# Valuation Mirage

## Practical Alternatives to Irrelevant Valuation Methods Taught in Business Schools and Failed Techniques Applied on Wall Street

# Chapter 1: Introduction to Valuation: *Valuation Overview and Classic Valuation Mistakes*

Making investments in capital intensive industries such as electricity generation, real estate, telecommunications, mining, transportation, oil production and infrastructure require business managers to bet a lot of money on uncertain economic variables far into the future. Dramatic valuation mistakes have been made in these and other capital intensive sectors because investors, bankers, managers, rating agencies, consultants and policy makers have incorrectly assessed future price trends, demand growth, plant performance, operating costs and capital costs that drive the value of investments. Analyses that underlie erroneous valuations have resulted in massive losses or gains for debt and equity investors and the problematic valuations often have had devastating effects for the overall economic vitality of a region. One obvious example of such a valuation disaster is the problems in forecasting real estate prices and risk analysis associated with mortgage loans that lead to the dramatic worldwide financial crisis of 2008. The mortgage loan crisis was of course not the first or the only debacle driven by faulty valuation analysis, and it will surely not be the last. For instance, in a short period after electricity deregulation was enacted by United States policymakers during the 1990's, the California electricity market was in turmoil; oil and natural gas prices quintupled; the darling of the industry, Enron Corporation, became the largest bankruptcy in United States history; merchant power plants around the world lost more than $100 billion in market capitalization; and certain companies that chose to hold on to nuclear plants earned enormous economic profits because of the way de-regulation laws were written[1]. This crisis came on the heels of the famous dotcom bubble in which massive over-investment in telecommunication companies and high tech companies resulted in dramatic defaults. Underneath all of these events were problems in valuation analyses involving errors in analyzing behavior of prices and/or underestimating the inherent risks of investments and/or believing in seemingly sophisticated analyses without independent verification. This book confronts standard valuation techniques taught in business schools which provide very little guidance on how to avoid these and other business failures and it offers alternatives that can lead to more sensible assessment of investments.

The ability to value assets and to assess risk of investments is vital for business managers who make decisions about borrowing or lending money, who invest in new projects, who acquire or sell companies, who sign contracts or who dispose assets. Without doubt, valuation and risk assessment are surely the two most important skills for any finance professional to master. The good news is that when gauging the value of anything -- from factories, to debt or equity investments, to marriage contracts -- the ultimate analytical problem can be boiled down to only two things. The first is forecasting your future net benefits, (measured in finance by prospective cash flows), and the second is assessing the risk associated with your projections. The bad news is that even though these two things are all that is at the root of any valuation problem and indeed are at the bottom of any subject in the study of finance, application of finance theory to real world investment decisions has been frustrating at best and just plain irrelevant at worst. To present valuation techniques that can improve real world investment analysis, subsequent chapters will delve into a variety of practical ideas and analytical models that project cash flows and assess risk. The first six chapters discuss general forecasting and risk analysis topics applicable to valuation of assets in any capital intensive industry. The final chapter addresses how to evaluate product price projections in valuation analysis.

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[1] Affidavit of Edward Bodmer, Comments of the American Public Power Association, FERC Dockets RM07-19-000 19-000 and AD07-7-000, Wholesale Competition in Regions with Organized Electric Markets, September 14, 2007, http://appanet.org/files/PDFs/bodmer.pdf.

Various models and techniques presented in this book are consistent with recent ideas presented by Nicholas Taleb and others which suggest that much of the theory of finance is plain rubbish. Four Nobel prizes have been granted in financial economics including (1) the work of Modigliani and Miller which concluded that other than tax effects, financing is not relevant to valuation; (2) the work of Harry Markowitz that assumed risk could be quantified through the standard deviation of returns; (3) the work of Sharpe who suggested that cost of capital could be boiled down to an equation known as the Capital Asset Pricing model and (4) the options pricing model developed by professors Black, Scholes and Merton. The financial crisis has demonstrated that each of these ideas is essentially useless in valuing companies and financial securities. If one ever needed proof that lending does impact value – contrary to Miller and Modigliani -- one does not have to look further than the market collapse that occurred after banks stopped lending in the last quarter of 2008. Assuming that historic measure of standard deviation has much if anything to do with risk – contrary to the ideas of Harry Markowitz -- was refuted by the fact that the risk people really cared about was protecting themselves from extreme market changes and not the regular movements in stock prices that can be measured with statistical analysis. Attempts to measure the cost of capital using the Capital Asset Pricing Model had been questioned long before the financial crisis and the model was irrelevant in explaining the value changes over the course of the crisis – putting the work of Shape further into question. Finally, sudden very large moves in the values of all sorts of things ranging from the oil price to exchange rates to stock prices confirmed that economic variables do not follow a normal distribution without mean reversion – making the work of Black, Sholes and Merton irrelevant. Despite evidence that questions the basic precepts of finance, teaching in business schools continues to emphasize the same tired old theories. The problem is that we still need valuation models and practical alternatives have not been suggested. Coming up with practical alternatives to the traditional financial theory and simplistic rules of thumb is the overall objective of the remaining chapters.

## Chapter Summaries

Topics to be covered in this text include construction of financial models, application of time series analysis in predicting economic variables, use of Monte Carlo simulation to measure risk, imputation of debt capacity to compute cost of capital, derivation of credit spreads, use of option price models in capital budgeting, development of forward price projections, analysis of long-term marginal cost and a host of other topics. There are multitudes of technical articles, books, technical reports and sophisticated software programs that address each of these subjects. The objective of the book is to put various technical models together in a practical manner and to show how reasonable analysis can be combined with sound business and economic judgment in assessing the value of investments. Many of the topics covered reveal that academic finance theory is all but useless and that a fundamental re-thinking of classic valuation techniques is necessary.

The book is organized by beginning with a survey of a few selected valuation nightmares in which application of valuation analysis failed miserably. The case studies of valuation mistakes are followed by practical discussion of how to develop cash flow projections that compute cash flows realized by equity and debt investors. With the ability to create cash flow projections in hand, the third part of the text reviews different ways to assess the risk of those cash flows ranging from sensitivity analysis to Monte Carlo simulation. In the fourth and fifth part, various techniques that convert the risk of making errors in cash flow forecasts into definitive valuation are described. This includes cost of capital measurement, debt capacity analysis and option price models. Finally, the difficult problem of using mathematical and economic analysis to forecast prices, costs and other value drivers over the lifetime of capital intensive assets is addressed. To preview how some of the various different analytical techniques are interrelated, a few key ideas included in each chapter are summarized below.

### Chapter One – Learning from Valuation Mistakes

This chapter introduces three general frameworks to valuation and then describes a few case histories in which classic valuation mistakes were made by bankers, investors and other financial analysts. The case studies recount situations in which finance professionals either have used valuation techniques that did

not adequately consider risks, or they misapplied valuation concepts and analytical models. Although some rather complicated models are presented and a bit of finance theory is discussed, the stories of valuation mistakes emphasize that better human judgment and intelligence with respect to very basic economic principles rather than increased sophistication in analytical techniques is the primary factor that could have avoided most of the valuation errors. The different valuation debacles confirm an obvious but often neglected point that all of the sophisticated financial models, elaborate mathematical representations of risk, application of intricate finance theory and other analytical tools are irrelevant without being supplemented by a healthy dose of wisdom and business sense. Many learned the hard way that risks associated with lending money to a waitress in who puts no money down on a $500,000 house cannot be gauged by running thousands of simulations by a credit analyst at Standard and Poor's on the 50th floor of an office building in Manhattan.

## Chapter Two – Financial Modeling for Valuation

Chapter two turns to practical development of financial models that are transparent, accurate, stable and present risks and value in an effective manner. This chapter may seem a bit out of place as and it is written for practitioners who either already create, analyze and make decisions using financial models or who will be required to do so in the near future. However in working through practical modeling issues, subtle but important differences in philosophy with respect to deriving the value of debt and equity investments underlying each model type are covered along with an explanation of how to structure the models. The chapter discusses how to design and program various different types of financial models including corporate finance, project finance and acquisition models and emphasizes the need to computation of debt capacity and problems with the classic discounted cash flow model that has its roots from the ideas of Modigliani and Miller. In presenting alternative models, the process of laying-out different modules for inputs, debt balances, depreciation and financial statements is included along with a description of how models can be used to get around the inherent problems of wide ranges in value produced by traditional techniques. The mechanics and the theory of modeling free cash flow, debt defaults and debt IRR, cash flow waterfalls, depreciation, taxes and covenants are discussed in the context of project finance and acquisition models. Practical hands-on programming techniques that can improve the ability of models to effectively present and measure risk are also included in the discussion. While effective and flexible financial models are the centerpiece of valuation analyses, this chapter can be skipped by those who are not interested in practical issues associated with developing financial models.

## Chapter Three – Risk Analysis and Time Series Models in Valuation

Chapter three addresses risk analysis in valuation by first presenting a variety of practical ways to directly measure risk using traditional sensitivity analysis, scenario analysis, break-even analysis and tornado diagrams. After describing judgmental approaches to risk analysis requiring judgment with respect to prospective economic variables, the remainder of the chapter focuses on use of time series models as the basis for mathematical quantification of risk – equations developed from statistical parameters such as volatility, mean reversion, price boundaries, industry productivity trends, correlation between variables and jump processes. Development of time series equations as part of the valuation process can appear very attractive because the equations can be used to compute statistics such as value at risk, probability distribution of equity returns and minimum required credit spreads. The discussion notes that while time series models can become addictive in seeming to provide answers to many financial problems such as deriving the probability of achieving returns for assets with different risk characteristics, the mathematical techniques can also be useless if statistics are used without explicitly considering the economic fundamentals that underlie the mathematical equations. Because of problems with application of historic data in construction of time series model parameters, the chapter explains how to construct time series equations using economic theory together with business judgment that allows for dramatic deviations between historic statistical data and prospective distributions.

## Chapter Four – Cost of Capital, Debt Capacity and Statistical Analysis

Chapter four moves to the question of converting risk into value. The discussion covers various different investment valuation techniques that compute the value of an investment given the riskiness of cash flows. Different approaches that apply the theory of finance, that use financial market data, and that extend option pricing theory to measure risk are presented. The chapter begins by reviewing traditional discounted free cash flow and cost of capital analysis. This demonstrates that the typical discounted cash flow techniques taught in business schools fail when it comes to most practical investment decisions. Next, an alternative way to translate cash flow risk into value is described which uses debt capacity to evaluate equity returns. The information source for the debt capacity analysis is financial criteria from bankers and credit rating agencies in asset and equity valuation. Because bankers and credit rating analysts are people who supposedly measure risk and to quantify the overall risk of an investment, valuation techniques derived from debt capacity should be superior to theoretical analyses using the capital asset pricing model which is founded on un-measurable parameters and is subject to bias. That is as long as bankers are doing their job. In fact, bankers and credit rating agencies have not had a stellar record in assessing risk. Because of this, a third method of translating cash flow into value is introduced that uses synthetic debt capacity measurement and time series analysis. This method simulates the theoretical debt capacity of a project through evaluating the probability of default and loss given default derived from time series parameters and Monte Carlo simulation. Once the theoretical debt capacity is established, the value of an investment can be derived through establishing a minimum rate of return as with the method that uses benchmark ratios from bankers and credit rating agencies.

### Chapter Five – Options Pricing Models and Valuation of Capital Intensive Investments

Chapter five considers the question of whether option pricing models can realistically be applied to real world capital investment and budgeting decisions. This is not the perfunctory option modelling chapter that seems to be part of any finance text these days. In working through the question of whether option models are really useful, emphasis is placed on practical issues involving the lack of the ability to hedge, mean reversion in cash flow, undefined exercise prices and required management action. These factors create a large gap between plugging in option pricing formulas and applying option theory in a practical manner to measure the value of real investments. The practical issues are illustrated using real options to delay development of an investment, cancel construction of a plant, cease operation, mothball and retire a plant by using different volatility, mean reversion, price boundary and correlation parameters. Monte Carlo analysis that accounts for the mean reversion and the specific operation of plants are compared to option models such as the Black-Scholes equation. At the end of the chapter, option concepts are applied to measurement of the value associated with a company being the “provider of last resort” where long-term capacity contracts exist along side customer options to switch suppliers when market prices fall.

### Chapter Six – Relative Valuation, Multiples, Weighted Average Cost of Capital and the Discounted Cash Flow Model

Chapter six describes practical application of valuation analysis using multiples such as the price to earnings (P/E) ratio and the enterprise value to the EBITDA (EV/EBITDA) ratio as well as detailed issues associated with the discounted cash flow model. This chapter is not like a typical textbook treatment of discounted cash flow analysis that describes how to compute free cash flow and then add the terminal value and discount the cash flow at the WACC. Instead, the chapter explains theoretical and simple mathematical flaws in the way simple weighting of debt and equity is computed in the WACC; it describes flaws in how betas are un-levered and then re-levered and it explains why the cost of equity does not necessarily increase for highly leveraged companies due to call option characteristics of equity capital. The chapter explains how to establish drivers that explain why a P/E ratio, an EV/EBITDA ratio or a market to book ratio should be at a given level. Finally the chapter bridges the very wide gap between theory and practice in applying the discounted cash flow model. Real world problems addressed include determining stable relationships between depreciation and capital expenditures, treatment of deferred taxes and long-run estimates of changes in deferred taxes, consistency between working capital changes and growth rates, use of multiples in computing terminal values and other issues.

### Chapter Seven – Forward Pricing Models with Micro-economic Supply and Demand Analysis

The most important component of any valuation analysis is forecasting the trends and variability in economic drivers of cash flow including prices, costs of new equipment and demand growth. The final part of the book describes practical forecasting issues involved in coming up with sensible predictions of these cash flow drivers. Marginal cost is introduced as the basis for gauging the future trends in prices. Marginal cost is not described in terms of esoteric economic theory, but rather in practical ways that can be used as a basis for key drivers in cash flow forecasts. Even though marginal cost may not equal the market clearing price, analysis of marginal cost and understanding of marginal cost concepts provides the foundation for evaluation of price trends and volatility. Subjects covered in this chapter include the definition of marginal cost, translation of capital investment costs into periodic marginal cost, and derivation of equilibrium long-run marginal cost with multiple technologies. Pricing theory is introduced by through defining various components of short-run and long-run marginal cost in markets capacity. Analysis of carrying charge rates demonstrates the manner in which cost of capital, inflation expectations and technology risk affects measurement of long-run marginal cost. In the final part of the chapter, a model of long-run marginal cost is presented to illustrate how one can develop reasonably simple methods to assess price levels that are sustainable over the life of an investment. This type of model of equilibrium long-run prices can be used as a benchmark to assess the reasonableness of forward price forecasts developed with far more complex forward pricing models.

The final part of the chapter describes analytical models that are derived from supply and demand analysis. The chapter applies time series concepts to incorporate volatility and parameters into pricing models. Through combining marginal cost concepts with time series analysis, a probability distribution of prices in different market can be simulated for use in debt capacity and option analysis. For example, the volatility can be computed assuming different levels of surplus or deficit capacity and differing capacity mixes through applying time series models of demand, fuel prices, maintenance outages and other factors.

## Valuation and Risk Assessment Frameworks

In the 1950s, at a time when corporations paid out high percentages of earning as dividends, the focus of valuation was on dividends per share. The big part of the valuation analysis was forecasting the dividend stream; and since dividends grew at a predictable rate, the risk was moderate. However, maintaining a steady divided stream posed a strategic dilemma for companies that wanted to grow fast. Issuance of dividends to shareholders can limit the growth rate in cash flow because money is dispersed to shareholders instead of being re-invested. In the end, value is created from two factors – the first being that the benefits of something exceed their costs, and the second growing something that is good. (Chapter 2 Appendix) After the 1950’s, when companies that earned returns above their cost of capital wanted to grow value by re-investing cash flow and therefore did not pay dividends, earnings per share became the focus of financial analysis. Price to earnings ratios and forecasts of earnings became the center point of value. More recently, valuation methods that focused on free cash flow available to debt and equity investors rather than earnings has become accepted by both academics and practitioners. (Chapter 4) Lately, new methods of equity valuation have become a topic of general interest. New paradigms applying option pricing concepts have been used for valuation of high technology stocks and other “new economy stocks” that have no current cash flow or earnings.

Valuation techniques described later in the text to perform the two tasks that underlie any valuation analysis -- forecasting cash flows then applying risk analysis to those cash flows -- can be generally grouped into a few different general approaches. The difference between the alternative methods corresponds to three central unresolved debates in finance. These three debates include:

- Should mathematical analysis drive risk analysis that underlies value or should judgment be the primary factor in the valuation process.

- Should valuation focus on real cash flow that goes into the pockets of investors – equity cash flow, or free cash flow that ignores the way assets are financed;

- Should the theory of finance be used in estimating cost of capital and hurdle rates or should real world estimates of what other investors are using in their analysis be used.

To introduce the valuation process and the manner in which risk of cash flows can be assessed, three general ways one could attack the problem are presented below. These three different techniques correspond to the three central unresolved issues in finance listed above. The three techniques include applying theoretical concepts; using mathematical analysis; and deriving value from debt capacity:

Finance Theory: The first approach involves using the body of financial theory that has been developed over the past fifty years which tells you that all risks of an investment can be incorporated into a cost of capital number that comes from measuring the beta parameter. Financial theory dictates that valuation decisions should be made by first forecasting cash flows which are independent of how the investment was financed and that you should not pay attention to how cash flows are split between equity holders and lenders. When applying finance theory, you are supposed to find the risk from analysis of historic stock price data to compute the beta parameter. The beta and growth rate assumptions are used to discount future cash flows – this is the well known discounted cash flow ("DCF") method.

Financial Math: A second valuation approach is to use stochastic mathematical models that quantify distributions of future cash flows received by equity and debt investors. With distributions of cash flows you can attempt to directly measure risk through computing probability distributions of returns to the project ("Project IRR") and cash returns to equity holders ("Equity IRR"). By using stochastic models to represent important variables in the valuation process, Monte Carlo simulation can be implemented and statistics such as value at risk and probability of default can be computed. For equity investors, the variation in the returns established from this mathematical process directly considers risk and return tradeoffs in establishing value. For lenders, the mathematical approach can directly assess the probability of loss relative to the credit spread which is the basis for computing the value of debt.

Debt Capacity: A third valuation method is to gather market-based financial ratio benchmarks used by people who put their money into debt and equity investments rather than applying beta statistics or Monte Carlo simulation. Financial ratios such as the debt service coverage ratio or the ratio of debt to cash flow can derive implicit debt capacity and risk assessments made by bankers and other lenders. When bankers choose to lend enough money directly to and investment which allows equity investors to earn a return equal to or above other investments, this information is very useful in risk analysis for the investment. Indeed, this approach implies that the debt capacity information is more useful than either the beta statistic or sophisticated Monte Carlo simulation in valuation.

Unfortunately, none of the three valuation approaches performs ideally in real world situations. The first approach, the one founded on financial theory, relies on parameters that are virtually impossible to measure and it offers little guidance for practical issues that arise outside of the classroom. Mathematical models that use time series equations and Monte Carlo simulation, the second technique, seem to solve many of the problems with financial theory through directly incorporating risk into valuation analyses rather than stuffing all of the risk analysis into un-measurable parameters. However the mathematical factors in the models are difficult to measure and the models are unwieldy to apply in practice. The third method that uses market data on actual required returns, credit spreads, debt capacity and valuation multiples applies practical information that often forms the basis for real investment decisions, but finding truly objective comparable data can be very difficult. Even worse, history shows that there has been a big problem with relying on bankers, consultants and other financial professionals for valuation information. Given difficulties with all three of the valuation approaches, subsequent chapters combine different techniques in order to come up with better ways to value long-term investments.

To contrast the three valuation approaches -- financial theory, market information and mathematical models – the discussion below uses a hypothetical investment in a Greenfield Liquefied Natural Gas (LNG) train.[2] This hypothetical investment requires a lot of capital and earns its revenues from selling a commodity, natural gas, whose prices are very volatile (Chapter 3). While companies like ExxonMobil and Shell make large investment in LNG, it is not easy to find companies that only invest in LNG trains.

## Valuation Approach One: Application of Financial Theory

The first way to measure risk and value for the new LNG investment is to try and apply financial theory by attempting to implement the Capital Asset Pricing Model (CAPM.) The basic idea of the CAPM is derived from the one of the few things we think we know in finance: if there is more risk, then, as long as the expected level of cash flows is the same, value will be lower and the required return will be higher. More technically, valuation of investments should adjust the required rate of return so as to account for potential variability in the cash flow forecast. Finance theory goes further and accounts for the potential to reduce some risks by building a diversified portfolio. This means that if deviations in cash flows from their expected levels are not correlated with the overall variation in cash flows produced by the LNG facility for other firms, then there should be no adjustment to the required return to account for the risk.

If two assumptions hold, historic stock price data could be used to derive the risk for the LNG project. Pretend that you can find a listed company on the stock exchange that just invests in similar LNG investments. Then:

> First, the expected future volatility of cash flows would have to mirror the past variation (e.g. past variation in gas prices would mimic future variation), and;
>
> Second, past data from financial markets must represent the risks faced by new investments (other stocks could be found that have the same risks as the LNG train).

For some investments, where there is a long history and stock market data for similar companies, and prospective variation on a new investment is similar to historic variation, it may be possible to use past data on the variation of stock prices companies relative to the variation in overall market (the beta) to compute the required equity return (this is the traditional CAPM familiar to everybody who has received an MBA degree.) For most real world investments, however, these two assumptions do not come close.

[2] The data is taken from the RAS Laffan III project. Data for the project is published in a pre-sale report by Standard and Poors. The pre-sale report is included on the CD.

One of the main tasks in implementing valuation using finance theory is quantifying the equity return that investors would need to be compensated for taking risk of the LNG investment. Once this rate is known, it is included in the weighted average cost of capital calculation and applied to estimated free cash flows in a baseline case. The general theory that increased minimum required rate of returns must account for increased risk is universally accepted by finance theorists and is an obvious point. But in practice, measurement of the risk premium for individual new projects remains one of the most daunting tasks in finance. One probably has no basis for measuring betas and detailed measurement issues with respect to beta are highly flawed; debates have not been resolved concerning the market risk premium that is a crucial input into the model that ultimately comes from psychological assessments of risk; and, most importantly, small variations in cost of capital and/or future growth would likely lead to such dramatic differences in valuation that the analysis probably would be rendered useless for a decision as to whether to invest. Most of the time, one can not find market traded stocks that replicate the risk of a new investment such as the LNG train; the historic volatility in stock prices has little relation to the prospective variation in cash flows; and worst of all, the entire CAPM theory has never been verified on an empirical basis. The fundamental problem with this first approach is that cramming all sorts of different risks into the measurement of the weighted average cost of capital cannot capture the essence measuring risk that is the basis for investment decisions.

To illustrate the problems with applying DCF and traditional finance theory in practice, the table below illustrates valuation of an LNG investment in three scenarios with different assumptions for cost of capital and terminal growth, two of the key factors that are very difficult to estimate in any valuation. The case with higher cost of capital and lower terminal growth results in a valuation almost 50% below the base case figure. On the other hand, the case with the lower cost of capital and higher terminal growth results in a value about 80% above the base case. These dramatic value differences do not come from arbitrary and/or extreme assumptions, but realistic alternative applied parameters with respect to three variables – beta, market risk premium and long-term growth that are at the very foundation of traditional DCF valuation (Chapter 4 and Appendix to Chapter 2.)

**Value Differences from Cost of Capital and Terminal Growth**

| | Base | Low | High |
|---|---|---|---|
| Beta | 1.00 | 1.50 | 0.75 |
| Rm | 5.00% | 7.00% | 4.00% |
| Growth | 2.00% | 0.00% | 3.50% |
| Rf | 4.50% | 4.50% | 4.50% |
| | | | |
| Ke | 9.50% | 15.00% | 7.50% |
| Explicit Period | 7.00 | 7.00 | 7.00 |
| | | | |
| **Enterprise Value** | **57,556** | **29,615** | **102,606** |
| **Pct Difference** | | **-48.5%** | **78.3%** |

## Valuation Approach Number Two: Stochastic Mathematical Analysis

One alternative to standard financial theory is to create mathematical models that predict both trends and variability in the future prices of natural gas, oil prices, interest rates and other factors that drive the value of the LNG train. These would include estimates of natural gas price volatility, the length of time it takes before prices revert to long run marginal cost. (Chapter 3 and Chapter 6) Along with a financial model (Chapter 2), one could then measure the probability distribution of returns to debt and equity investors. The probability that a rate of return will be below the risk free rate could be derived for our LNG investment. If this probability of experiencing rates of return below the risk free rate is fairly low, then a compelling argument that the investment has a positive value could be made because it only has upside relative to an alternative investment in a risk free security. Further, application of this second method allows you to compare the probability distribution of cash flows resulting from the LNG train to alternative investments. For instance, if another investment has both lower expected returns and more dispersion in returns, the LNG train is surely a better investment.

Unlike the method that uses financial theory, this second valuation approach directly addresses risk through seemingly objective mathematical measures of volatility and other statistics rather than dumping all the risk into a very difficult to measure cost of capital number. Simulation can be very seductive for those who like a lot of analysis. Yet we will see that practical application of mathematical analysis is generally difficult because small changes in prospective statistical factors such as volatility, mean-reversion, price boundary parameters produce very different pictures with respect to the probability of achieving a given return on our equity investment.

The two graphs below illustrate application of the mathematical simulation using the same data as above with respect to the LNG investment. Rather than placing all risk analysis into beta and the cost of capital number, the risk of realizing different natural gas prices – most probably the major source of risk in the project – are directly analyzed. With respect to natural gas prices, the first graph assumes 15% volatility, a long-term marginal real price of $4.50 and a mean reversion percent of 40%. (Chapter 3) In this first scenario with lower volatility there is only about a 5% chance that the investment will earn less than the risk free rate. That is pretty good because that is a 50% chance that the return will be above 15%. On the other hand, if one changes some of the economic parameters with respect to natural gas price assumptions, the investment picture changes dramatically. If the volatility is 25%, the long-run equilibrium price is $4.00 and the mean reversion is only 10%, then the probability of experiencing a return below the risk free rate increases to about 55%. Were there is only a 5% chance of falling below the risk free rate, the investment would certainly be attractive; however were there to be more than a 50% chance that you will not even earn a the same as a risk free security, making the decision to investment would be far more challenging.

If only we could develop parameters to model factors such as the future trend and volatility natural gas price, the process would be wonderful. In practice, claiming that you know future volatility, mean reversion, long-term marginal cost and other factors for economic variables that can have sudden jumps and non-linear trends is not only difficult but pretending that you know these things is about as reliable as believing the predictions of a psychic. Pretend you were making a mathematical model of the movement in oil prices in 2002 when the price was $35 per barrel. At that time, it is very doubtful that your model would have suggested any probability at all of hitting prices in 2008 of $149 per barrel (although with hindsight, many may say they had predicted this.) You would also not have forecast the subsequent fall in oil prices in the autumn of 2008 (Goldman Sachs and many others were sure that oil prices would reach more than $200 per barrel by the end of the year.)

## Valuation Approach Number Three: Debt Capacity Analysis

Rather than concerning ourselves with estimating the cost of capital or complex mathematical models in assessing the LNG facility, one could use the third approach derived from assessing the returns required by equity investors in other LNG transactions. This process begins by finding out what rate of return actual investors need in order to put their money into a plant such as an LNG train rather than attempting to estimate beta or measure volatility. Then, given the returns generally known to be required for this type of leveraged investment -- say 14% -- you could see if a bank would lend enough money at a reasonable interest rate such that we could earn a return of 14% or even more. Such analysis would involving having market insight as to real world returns that are required by actual investors and then using benchmark data on financial ratios such as the debt service coverage required to obtain reasonable loan terms. The starting point here is not estimating beta or volatility, but a target credit classification. Once the target is established (e.g. BBB) the maximum amount of a loan for that credit classification can be estimated from projected financial ratios (Chapter 4). The level of the financial ratio that drives the size of the loan that is acceptable to lenders depends explicitly or implicitly on their assessment of the volatility of the underlying operating cash flows – the larger the loan relative to the investment, they are telling you that there is less the implied risk of operating cash flow. Therefore, the size of the loan can be used to infer risk. This measure of risk does not have all of the problems discussed above associated with the beta parameter and the estimated risk premium. For those more interested in sophisticated financial terms, deriving volatility and risk from debt capacity is analogous to finding the implied volatility from option prices – just as you need a traded option to find the volatility that the market believes will occur. (Chapter 5)

By assessing the overall risk of an investment with debt capacity, risk is no longer measured from financial analysts inside a company where internal staff – probably having an emotional attachment to the project or (if they are from the treasury department) not understanding the specifics of the investment -- attempts to measure the weighted average cost of capital. Using the equity returns rather than overall project returns to assess the value of an investment goes against most of the traditional analysis taught in finance textbooks which emphasizes attempting to apply the CAPM an then measuring the weighted average cost of capital. As with the mathematical approach, one does not have to worry about measuring beta or the virtually impossible to measure market risk premium in making an investment decision. The discussion below elaborates how one could argue that other equity investors and bankers should be a good independent source of information and the valuation decision would now depends on people who really put their money at risk rather than some theoretical formula. In implementing this approach, it is too bad that bankers and credit rating agencies have often done such a poor job in risk assessment – the biggest examples of this are pouring money into new economy stocks in the dotcom bubble and investing in financial products made up of subprime loans which lead to the 2008 financial crisis.

To illustrate the debt capacity approach to valuation, assume bankers make three different assessments of risk for the project shown on the table below. In the first case, shown on the left column, bankers will lend for a term of 14 years and provide 55% of the financing for the project, resulting in a debt service coverage ratio 2.29 times. This results in a return slightly below the hurdle rate of 14%, leaving the investment decision questionable. On the second column of the table, bankers are assumed to lend much more aggressively to the project – presumably because they believe there is less risk associated with operating cash flows of the project. The expected level of operating cash flow is identical to the first case, but leverage is 90% and the tenor is 20 years. This results in a smaller debt service coverage ratio buffer of 1.58 times which is justified by the fact that bankers have made a lower assessment of operating risk. Because the rate of return on the project with no leverage (the project IRR) is more than the interest rate, the increased leverage results in a much higher equity return of 25.6%. The final column illustrates a case where bankers believe the operating cash flows have higher risk. With the higher risk, bankers are assumed to only lend 31% of the total capital of the project, because they need a buffer of 3.15 times. With the lower leverage the earned return is only 11.8%, implying that one should not proceed with the investment. In this example, the debt capacity drives the investment decision and the implicit cost of capital of the project.

This third debt capacity valuation method implies that bankers are implicitly making the risk assessment about the volatility and trends in future prices (even if they do may realize that is what they are doing.) Although the approach seems to be more practical than the other two methods, as already discussed, valuation mistakes made by investment bankers, credit rating agencies and commercial bankers have been dramatic over the past few decades for mergers, acquisitions, project financings, structured financings and other investments. These mistakes imply that use of judgments made by others may in fact not be all that reliable for assessing the risk and coming up with the valuation of our LNG investment.

| **Value Differences from Debt Capacity** | | | | |
|---|---|---|---|---|
| | | Base | Aggressive | Conservative |
| Overall Project IRR | | 9.48% | 9.48% | 9.48% |
| Leverage | | 55.00% | 90.00% | 31.00% |
| Term | | 14.00 | 20.00 | 10.00 |
| Interest Rate | | 6.00% | 6.00% | 6.00% |
| | | | | |
| Cost | | 37,000 | 39,000 | 36,000 |
| Repayment Method | | Level | Amortizing | Level |
| | | | | |
| **Equity IRR** | 25.6% | **13.05%** | **25.61%** | **11.84%** |
| **Average DSCR** | 1.58 | **2.29** | **1.58** | **3.15** |

## Comparison of the Alternative Valuation Approaches

When the stock market plunged after Lehman Brothers declared bankruptcy in 2008, many financial commentators suggested -- or, more typically, shouted -- that the root cause of the market decline was that the price of risk had increased. As is typical when listening to financial experts, this sounds good even if nobody has any idea what it really means. In fact the analysts seemed to be implying that the bigger driver of stock price declines was not in the level of expected future cash flows but in the value attached to the risk associated with the cash flows. One of the traits of financial commentators is that they seem to enjoy listening themselves use fancy terms such as the price of risk to confuse people. While many of the terms are irrelevant, in this instance one can use their term the price of taking risk to contrast the three valuation methods discussed above. So as to make this comparison, lets' first see how the alternative approaches may explain the market decline driven by the general belief that the world had become riskier. In measuring the price of risk, a finance theorist (approach one) would attempt suggest that the equity market risk premium part of the CAPM increased – with a higher cost of capital faced by all firms, values would decline. This expected market risk premium is a number that theorists love to study but it is essentially a psychological concept representing the level of return above the risk free rate required by investors to accept the higher volatility of stock investments than risk free investments. The equity market risk premium is very difficult, if not impossible, to measure in the short-term and it does not change with interest rates, inflation rates, or other observable factors, but rather only with the psyche of investors. This means that the CAPM boils down to psychology (Chapter 4).

Advocates of the mathematical approach to risk assessment would explain the increase in the price of risk after the Lehman bankruptcy by an increase in the volatility of underlying economic variables such as uncertainty with respect to housing prices consumer spending and GDP growth. This increased general uncertainty in economic variables means that investment returns have a higher dispersion and also that the probability of default on loans has increased. With increased volatility, banks are less willing to lend and capital expenditures decline leading to a general decline in economic activity. As with the financial theory, measuring how much the volatility in underlying variables has increased cannot be accomplished from statistical analysis of historic data.

Finally, those arguing for use of practical market data (approach three) would suggest that the increased price of risk is measured by less of a willingness of bankers to loan money -- a credit crunch. The more limited lending implies that investments have a higher cost of capital and reduced value. If the tightening of credit as measured by the gearing available for different investments is known, then the price of risk can be objectively measured. The dramatic changes in opinions about credit quality is illustrated by the fact that Lehman Brothers had a bond rating of A just before the bankruptcy.

The contrast between the measuring the price of risk from debt capacity (approach three) and from finance theory (approach one) is shown below with a hypothetical investment decision in two renewable energy projects. Assume that an investment in one of two alternative projects is being considered. Project A is an off-shore wind farm where production and cash flow variability results from uncertainty with respect to maintenance expenses, potential availability problems, and variation in wind speeds (the wind speed variation magnifies production variation because of the physics of converting wind into electricity.) Project B is a solar project with less cash flow uncertainty because of the manner in which changes in sunlight affect electricity production and because of less uncertainty with respect to the availability of the machine driven by the solid state nature of the equipment. Using government mandated tariffs and capital costs of the two projects, the overall rate of return on capital for the off-shore wind project -- the project IRR -- is 11.06% while the project IRR (the rate of return with no debt leverage) for the solar project is only 7.62%.

Finance theory suggests that a cost and benefit analysis should be performed to determine which investment is better. When an investment has a rate of return above its cost of capital, value is created. That simple idea is essential in thinking about any investment decision. To compare costs and benefits, the rate of return should be compared to the risk adjusted opportunity cost otherwise known as the weighted average cost of capital ('WACC"). The WACC is in turn driven by the estimated cost of equity and beta (some companies attempt to be more sophisticated by establishing a different cost of equity for different types of projects.) Assume that the cost of capital process (probably a number given ty you by somebody in the Treasury Department) establishes a WACC of 9.69% for the off-shore wind project and a WACC of 8.94% for the solar project. Using this WACC to measure risk, the wind project generates positive value because its rate of return of 11.06% is greater than its WACC of 9.69%. On the other hand, the solar investment has a negative value as its rate of return of 7.62% is below the WACC of 8.94%. Comparison of the project IRR and the WACC is equivalent to standard discounted cash flow analysis that is the foundation for valuation assessments behind finance theory. The first method would therefore suggest that an investment should be made in project A – the wind project, but not in project B – the solar project.

Where debt capacity is used in valuation, the amount of debt financing rather than WACC drives the investment decision. Assume that in order to achieve a BBB bond rating, the wind project can only raise can raise 53% debt leverage while the solar project can raise 84% debt. This difference in leverage is driven by the risk assessments made by bankers who account for the greater revenue variability and the greater higher operating cost risk of the off-shore wind farm. As long as the overall project IRR is greater than the after-tax cost of debt, the leverage increases the earned return on equity for both projects (Chapter 4). However, the effect of leverage is much more for the solar project (project B) due to the higher debt to capital ratio. Because of the difference in leverage, the solar project now earns an equity return of 21% while the wind project only earns a return of 13.4%. To apply the debt capacity method, that the return to equity rather than the overall return drives the investment decision and this return is given by market intelligence rather than by manipulating mathematical formulas. If the return criteria is 15%, then the solar project with the higher return should be selected instead of the wind project. The difference in equity return is driven by the assessment of cash flows made by lenders who actually put their money on the table. Financiers who lend money to specific projects and whose job it is to classify risks arguably provide a more objective source of risk assessment than traditional approach taught in business schools that involves measuring risk with the CAPM and Beta. Indeed, the notion of using debt capacity to deal with the difficult problem of risk measurement seems to solve the perplexing problem of incorporating risk in valuation.

**Evaluation of Project Investments with Equity IRR and Debt Capacity**

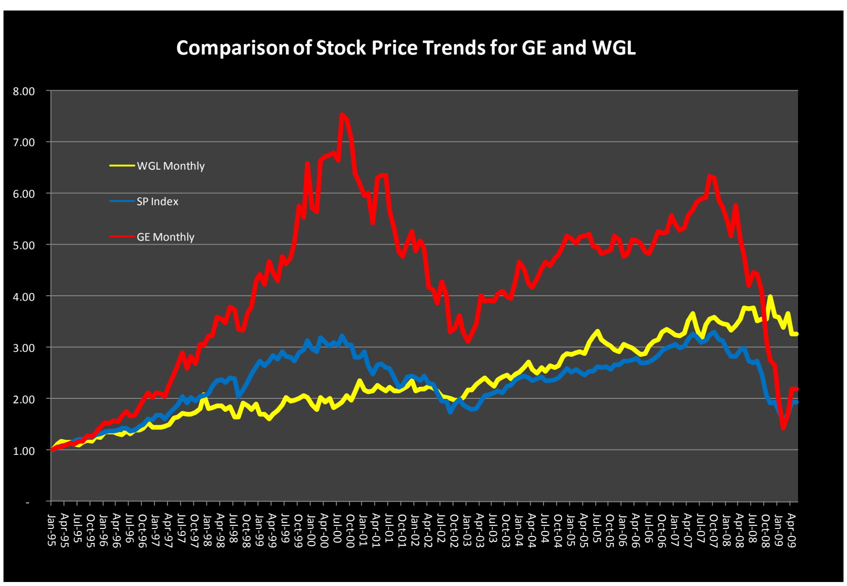
- PROJECT A
- PROJECT B

| Financial Results | Off-Shore Wind | Financial Results | Solar |
|---|---|---|---|
| **Project Finance Statistics** | | **Project Finance Statistics** | |
| Equity IRR | **13.41%** | Equity IRR | **21.06%** |
| Project IRR | **11.06%** | Project IRR | **7.62%** |
| WACC | **9.69%** | WACC | **8.94%** |
| Senior Debt IRR | 6.55% | Senior Debt IRR | 5.91% |
| Junior IRR | NA | Junior IRR | NA |
| Minimum DSCR | 1.45 | Minimum DSCR | 1.20 |
| Average DSCR | 1.60 | Average DSCR | 1.77 |
| LLCR | 1.58 | LLCR | 1.32 |
| Average Life | 4.66 | Average Life | 10.24 |
| **Project Fiance Features** | | **Project Fiance Features** | |
| Debt Tenor | 11.00 | Debt Tenor | 18.00 |
| Leverage | 63.0% | Leverage | 89.2% |
| Cash Trap | 1.15 | Cash Trap | 1.15 |
| Cash Sweep | Partial Sweep 70%-3 | Cash Sweep | No Sweep |
| DSRA Months | 6.00 | DSRA Months | 3.00 |
| Repayment Type | Annuity | Repayment Type | Annuity |

Project IRR minus WACC – traditional finance – would make A look better

The sup-prime crisis and the chaotic period in the financial markets that began in the summer of 2008, referred to as the financial crisis requires a return to evaluation of basic financial principles rather than to repeat past approaches that take no account of, or are inconsistent with, very different prevailing market circumstances. The financial crisis has shown that many financial professionals need to go back to harbor and take a hard look at everything from models such as the CAPM that supposedly measure cost of capital to the basic question of what constitutes risk. A number of theories, models, and financial strategies related to valuation have proven to be erroneous or, more often simply irrelevant in explaining dramatic volatility of asset values. There is nothing wrong with admitting that past approaches you have learned and used are not adequate to the challenges of the current environment and examining the pertinent risk and financial issues using approaches more attuned to the undeniable changes in the markets. On the other hand, blind adherence to financial theories and models that do not work when fundamental assumptions are upset should no longer be acceptable in valuation analysis.

The sub-prime crisis and many other valuation mistakes should prompt re-thinking about the relevance of finance theory with respect to a variety of issues including risk measurement and the manner in which risk affects investment decisions and the cost of capital. Reviewing the published beta and stock price performance for different firms shows how reported betas can be all but irrelevant in capturing firms' actual risk differences. According to Value Line Investment Services, WGL (a very safe utility company protected by regulation) has a beta of 0.75. On the other hand, General Electric (GE), a multiple industry company with volatile stock prices subject to all sorts of risks, has a Value Line beta of 1.00 – that is, its risk is virtually the same as that of the entire market. With a CAPM market premium of 4.5% commonly used by investment banks before the financial crisis, the Value Line betas imply that the difference in the risks of a GE investment and a WGL investment would demand a premium for investing in GE of only 1.13% (4.5% multiplied by 1.00 minus 0.75). When one looks at stock prices of WGL and GE (illustrated below) one can see how absurd this risk premium is. GE's stock price fell from $37 to $8, from the top to the bottom of the market (a decline of 77%). Over the same period, WGL fell from $31.74 to $30.01 (a decline of 5%). It is difficult to imagine anybody suggesting that a 1.13% difference in return really captures GE's greater risk – or, conversely, the greater safety of the WGL investment.



Using debt capacity along with sound thinking about the fundamental economics of projects and mathematical simulation provides an alternative to risk assessment that offers more guidance to decision makers. The example of Project A and Project B above resulted in a return on equity difference of 7.6% (21% minus 13.4%), which is far greater than risk differences that result from the CAPM. If lenders would rigorously establish the debt capacity of an investment (as did not happen in the sub prime experience), investors then would have a much more objective basis than the CAPM to assess risk as part of investment decisions. One cannot simply plug a couple of numbers in a formula as with the CAPM, but it should be difficult for most people to accept that risk assessment can be boiled down to a simple linear equation with three inputs. Because of the problems that have occurred when bankers assess risk, using mathematical simulation to compute how bankers should theoretically judge risk is an alternative.

During the extremely volatile falling equity and debt valuations, nobody complained about Bloomberg mis-estimating betas or that financial academics had got the risk premium entirely wrong. On the other hand Congressional hearings were held involving the performance of the rating agencies after an outcry about many Collateralized Debt Obligations (CDO's) that were rated AAA even though they had been losing 30% of their value because of the increased probability of default.[3] The risk assessment used by these agencies was clearly central to valuation of the investments collateralized debt instruments and drove investment decisions ranging from laborers in California with no income tax forms making investment decisions to purchase homes they could not really afford (because they did not have to make a down-payment) to Norwegian investors including sub-prime CDO's in their portfolios. The criticism of rating agencies came about because they did affect real investment decisions and the ignorance of financial theory reflected the irrelevance to real world valuation.

## Efficacy of Making Cash Flow Forecasts and Risk Assessment in the Valuation Process

Given problems with all three of these general approaches to valuation, as well as cash flow forecasts, some may be tempted to simply throw their hands into the air and rely on our gut feel instead of performing any numerical valuation analysis. All three of the approaches require cash flow forecast and when cash flow forecasts are inaccurate, valuation is wrong. Nassim Taleb, author of two books that have change the way a lot of people think about finance, asserts in a convincing way that attempts to make forecasts of cash flow using financial models is inherently fraudulent and making a cash flow forecast is equivalent to going to a fortune teller. He states that "…we have a built-in tendency to think that we know a little bit more than we actually do…Why on earth do we predict so much? … Why don't we see how we (almost) always miss the big events? I call this the scandal of prediction."[4] If one was making a cash flow forecast underlying a valuation analysis in the year 2000 that covered the subsequent decade, we probably would not have incorporated the sub-prime crisis, one hundred and forty dollar oil prices, the events of September 11, 2001, the rise of private equity funds and the financial crisis. When making a forecast in 2010, unusual events like this will surely occur again meaning that you will know that any forecast is completely wrong before making it.

Despite inherent problems with the whole idea of predicting the future and making cash flow projections, the alternative of not making any analysis in evaluating major investment decisions remains unacceptable to most business people. Foregoing analysis and leaving decision making to a gut feeling would ignore information and leave room for biased or even corrupt decision making. The analysis process should make it clear where cash flows come from. Indeed, it is often the opaque investments that are very difficult to analyze that have caused the most difficult issues in valuation.

[3] Morris, Charles, "The Trillion Dollar Meltdown", New York, New York, 2008. Morris notes that "when the subprime CDO market first took off in 2005, subprime defaults were only in the 3 percent range. A 20% cushion of equity and mezzanine debt for the top layer seemed like ample protection, so rating agencies generally assigned triple-A and double-A ratings to the top 80% of bonds in the CDO … and top CDO tranches were priced at a range of 10 to 25 basis points." As default rates moved to 10%, the value of the high rated fell in value by 30 percent. Page 114-115.

[4] Taleb, Nassim, "The Black Swan", Random House, New York, New York, 2007, page 138.

The problem with these ideas is that while it is easy to criticize forecasting, it is much more difficult to come up with a better alternative. One can simply become afraid to any investment and take any risk, but then there would also be no way to make investments that improve productivity in the economy. In order to do the best we can in reducing problems with forecasting, we should start by studying the details of mistakes that other people have made.

# Valuation Mistakes

## Introduction and Valuation Errors made in Sub-prime Lending

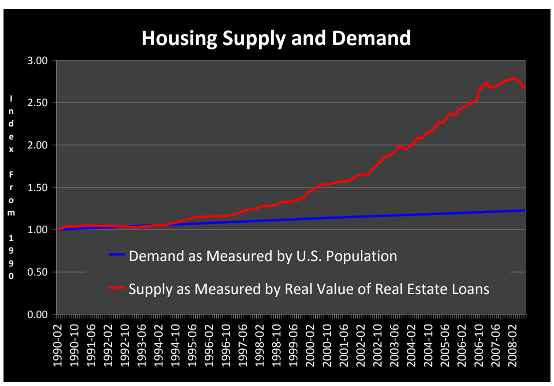
Much of this text explains somewhat technical approaches to valuation through applying a combination of economic theory, mathematics and financial principles. While the understanding of any discipline requires knowledge of underlying technical and theoretical principles, when it comes to valuation, learning from past mistakes is also essential, and probably even more important. The idea behind presenting a few case histories of valuation mistakes before working through technical details of analytical models is both to introduce selected valuation topics and also to prompt thought about general valuation issues. The case histories presented below include analysis that resulted in bad investment decisions that caused equity and/or debt investors to lose a lot of money.[5]

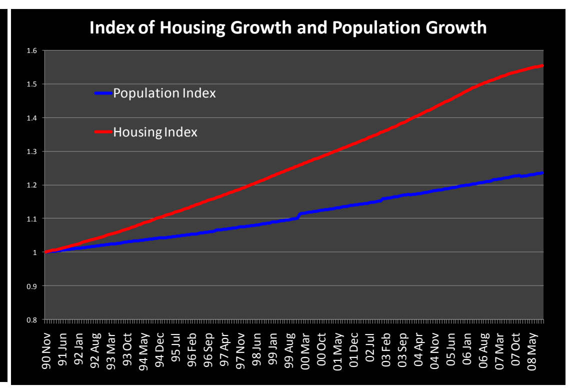
In discussing these cases histories, errors are classified into a few different categories and each case is used to describe a single type of valuation mistake. By concentrating on one valuation issue in each case study, the problems that occurred in many of the actual circumstances are somewhat simplified. Many of the case studies discussed below involved more than one valuation error even though the emphasis is on a single issue. Prominent valuation errors include: (1) the assumptions that prices can increase when there is increasing supply and over-supply in a market; (2) the failure to check complicated opaque models with simple tests or metrics; (3) the adoption of complicated analysis made by others without adequate independent analysis; (4) belief in supposedly innovative new valuation techniques that focus on other things than future cash flows and their risk; (5) ignoring the underlying marginal cost drivers of prices in making forecast; (6) assuming that value can be created without fundamental competitive advantage; (7) failure to understand non-linear upsides and downsides of many investments when assessing risk; (8) not paying attention to the benefits of flexibility in assets and the costs of inflexibility; and (9) application of statistical approaches that assume historic trends and volatility in key variables will continue. All of these things factored into the mother of all valuation nightmares – the financial panic precipitated by declines in the U.S. housing loans known as the sub-prime crisis. A very general discussion of the explosive mixture of valuation errors that contributed to the sub-prime mess is presented below before specific valuation mistakes are discussed in more detail.

[5] In some of the cases, such as with the discussion of the California crisis, the case studies do not delve into all aspects of the case that created poor decisions and investor losses. Instead, the discussion concentrates on particular aspects of the case that demonstrate problems in application of valuation techniques.

The first and perhaps the most surprising error made in the mortgage crisis was that investors in the sub-prime loans assumed that prices of homes would continue to increase at the same time supply was dramatically increasing. This is like assuming that prices, margins and volumes all increase at the same time when developing a financial model (Chapter 2). Such an assumption that defies the most basic of economic principles (increasing supply and increasing prices) may be possible in isolated circumstances such as innovative technology, but is very dangerous in most situations. At the height of the housing boom, the surplus of residential homes was obvious to anybody who simply drove around sprawling suburban areas of American cities where it was clear that the supply of housing space was increasing much faster than the overall population. (The idea of actually looking at what was happening was apparently not relevant to many financial modelers. There are stories of modelers refusing to leave the bus when touring real estate they were analyzing). One investor bet against the housing markets after visiting areas with a lot of subprime loans in Florida and observing the oversupply. According to Michael Lewis author of "Liars Poker", the investor "flew down to Miami and wandered around neighborhoods built with subprime loans to see how bad things were… [he exclaimed], 'oh my god, this is a calamity here.'"[6] The obvious surplus supply in housing is related to another valuation mistake that involves not checking the logic of complex financial models by doing something simple like visiting the investment project, driving around or looking at pictures.

The dramatic increase in supply relative to demand is demonstrated on the two graphs below. The graph on the left presents the total volume of real estate loans in the U.S. – representing supply and the total population – representing demand.[7] The graph on the right also demonstrates the oversupply of homes by comparing the number of homes with population.




On the left side of the above graph, it can be seen that demand and supply were relatively stable for much of the 1990's as the two lines were increasing at about the same rate. However, surplus supply was occurring well before most people had heard of the term sub-prime and values crashed in the middle of 2007. A fall in housing prices should not have been surprising to anyone who has attended the very first day of a basic economics course. Rather than worrying too much about beta, WACC, terminal growth rates or Monte Carlo simulation, the subprime crisis demonstrates that risk analysis and valuation must begin by assessing the fundamental economics of the investment and include simple checks of the underlying logic (graphing supply and demand or driving around and observing suburban sprawl.)

A second problem with valuation analysis in the subprime crisis was that investors and lenders did not pay attention to marginal cost when evaluating housing prices and instead discussed made themselves believe in esoteric theories associated with demand. The manner in which risks of housing price declines were evaluated is demonstrated by Michael Lewis:

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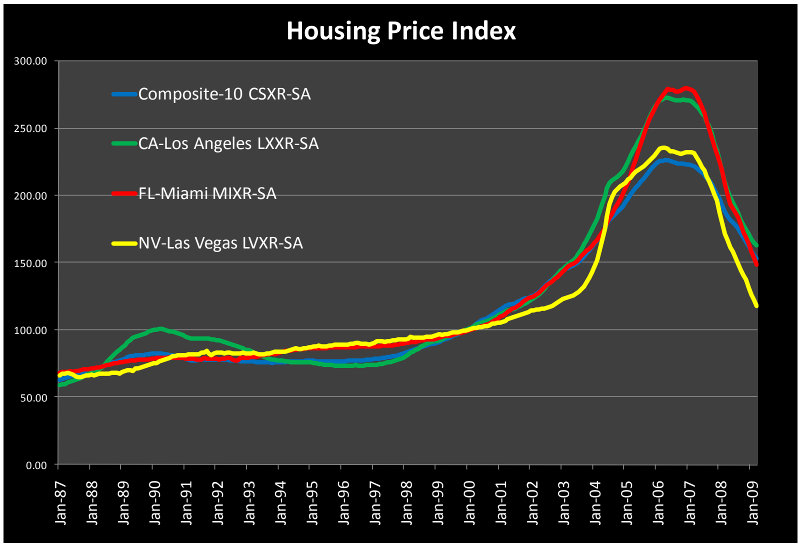
[6] Lewis, Michael, "The End" http://www.portfolio.com/news-markets/national-news/portfolio/2008/11/11/The-End-of-Wall-Streets-Boom? Page 5.

[7] The data are taken from the St. Louis Fed and include total population as well as loans to real estate by banks.

> *"Loans were granted on the presumption that housing prices would follow trends experienced since 2000, and continue to increase. After all, nominal housing prices had not fallen on an annual basis since World War II. According to one story an investor called the rating agency Standard & Poor's and asked what would happen to default rates if real estate prices fell. The man at S&P couldn't say; its model for home prices had no ability to accept a negative number. 'They were just assuming home prices would keep going up…'"*[8]

The big problem with this assumption that housing prices could not fall was that the relationship between house prices and marginal cost was completely out of whack. Over the tenure of the increase in house prices, the cost inputs to housing -- building materials such as lumber and cement; the cost of labor; the cost of capital and even the cost of land that drive the change in the marginal cost of housing -- were stable. Further, houses were often built in vast open areas where the cost of land was not a constraint.

During the period when housing prices were increasing, various seemingly sophisticated explanations were provided by experts to justify the increase in prices. These were generally driven by increasing housing demand, most notably the low interest rates that made the overall cost of owning a house lower. The valuation error was to concentrate on demand and ignore the marginal cost that represents the supply curve and assume that price can exceed marginal cost indefinitely. One of the most fundamental of economic principles dictates that prices eventually move to long-run marginal cost, or in the case of residential real-estate, the real cost of building a new home. As a corollary, economics suggests that prices can move all the way down to short-run marginal when surplus capacity exists. This implies that the dramatic increase in prices could not be sustained and risks of price decreases should have be part of every valuation assessment. The graph of median housing prices in the U.S. shown below demonstrates how housing prices dramatically increased at the turn of the century and then fell to levels consistent with long-term trends and inflation.



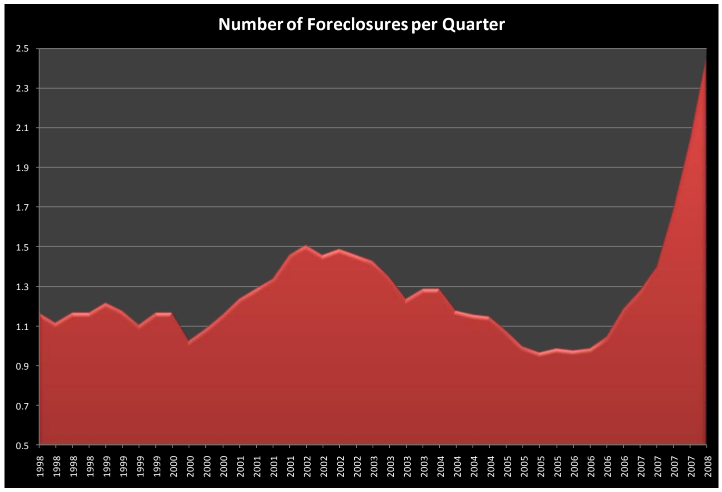

8 Lewis, ibid.

Trends in prices shown in the above graph demonstrates that prices did not keep increasing or remain at the high levels experienced before 2006 in the face of oversupply in the market. With hindsight, price declines should have been expected as they have simply reverted back to long-run equilibrium levels (as the size of new homes increased dramatically, one wonders just how large a home people really need). Both surplus capacity in the market and diminishing demand for new homes after the market was saturated meant that declining house prices should have at minimum been considered a reasonable possibility in any valuation analysis. Certainly this should have been part of downside scenarios that are a basic part of lending (Chapter 3). The decline in prices meant that that they simply are following a cyclical pattern and reverting to their long-run marginal cost. With hindsight the decline should have been obvious. The more interesting question is why prices stayed so high for so long. One possible reason is given by Robert Schiller: People give "increasing credibility to stories … that appear to justify the belief that the boom will continue. People think the world [that results in price movements] is led by independent minds who invariability act with great intelligence."[9]

A third problem with valuation analysis during the subprime boom was how investment analysis inappropriately used historic trends in predicting future cash flow and risk. Instead of simply extrapolating historic data using simple or elaborate statistical analysis, the underlying source of trends and volatility in the numbers must be understood (Chapter 3). However when making loans or insuring loans with credit default swaps, credit rating agencies, banks, other lenders and insurance companies often used databases that tabulated historic default statistics. Indeed, a lot of the work created by the Basel II banking agreement (which ironically was supposed to assure that a banking crisis would not occur) was derived from analysis of historic default rates on loans. Such historic statistics may work well in predicting the wind speed, solar radiation, the likelihood of finding oil, life expectancy and various other variables. However statistical analysis of historic data can go badly wrong when applied simplistically to economic variables such as demand growth, price changes, credit card loan delinquencies or consumer behavior (Chapter 3).

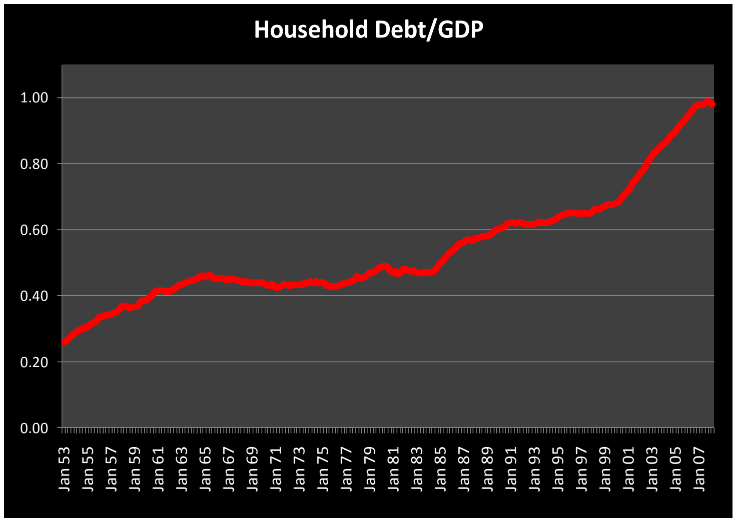
Because of increasing leverage of homeowners, fraudulent and dramatically relaxed lending practices, declining home prices and a slowing economy, historic default rates turned out to be irrelevant in predicting bad loans. Despite the drivers of higher default rates, in 2006 subprime lenders were projecting default rates of only 5%. A realistic projection of potential default rates required judgment and development of scenarios that included declining home prices, a slowing economy and increased energy prices (none of which were impossible to predict) rather than statistical analysis. The problem with relying on historic statistics is demonstrated in the graph below which shows trends in foreclosures. The graph illustrates the dramatic increases in foreclosures which increased 53 percent in the summer of 2008 relative to the year earlier.

[9] Shiller

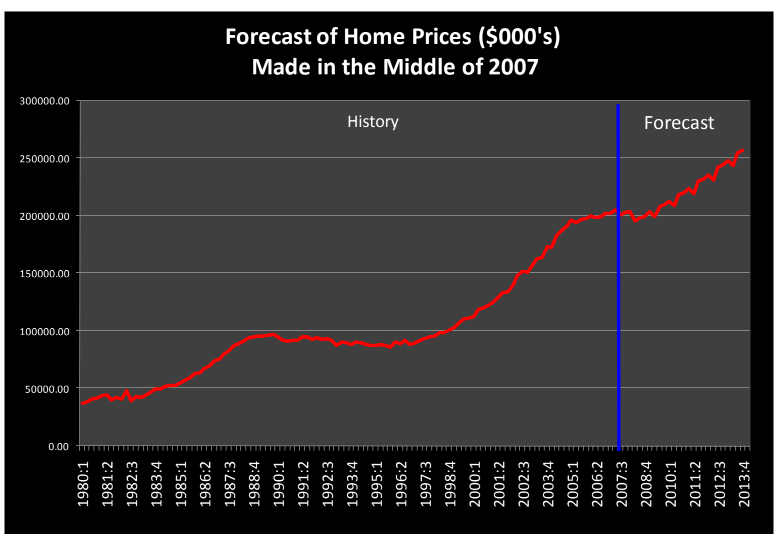



The fourth problem in the subprime crisis was belief in supposed new financial techniques without fully working through the logic of the innovations. Investors accepted valuations of complex collateralized debt obligations without making simple checks of whether they made sense (Chapter 2). The idea that structured finance products that packaged loans together and distributed different pieces of the cash flows different investors could reduce risk is an example of this phenomenon. Given the high credit rating of the collateralized debt obligations and the obvious risk of the individual subprime loans, the structured investments could produce values which were greater than the sum of the individual loans. These investments were somewhat complex and opaque and investors did not perform due diligence, but instead accepted the expertise of rating agencies and marketing professionals. As with other investments, very smart financial professionals could make the investment sound convincing by using fancy terms and talking fast. In fact, when one looked underneath the so called structured investments it was apparent that they combined loans that were made that ignored the most fundamental of lending practices, i.e. that cash flow should be sufficient to repay debt service. In the extreme, reckless loans named NINJA loans (No Income, No Job, and no Assets) were dispersed on the presumption that housing prices would continue to increase.

If the basic economic logic of the underlying loans – that one could ignore basic lending practices – does not make sense, then the package of loans also does not make sense, no matter how much sophisticated mathematical analysis is performed. Despite problematic logic that was the foundation for the loans, the financial products often had strong credit ratings and were developed by sophisticated professionals. In discussing the value of debt (Chapters 3, 4, and 5) one of the basic ways to evaluate its risk and value is to review the cash flow relative to debt. If the cash flow is too low compared to the level of debt, the debt cannot be repaid. When examining this ratio on an aggregate level rather than a company basis, the risk of the home loans is apparent. The graph below shows that even though income as measured by GDP increased, the debt increased much faster. As it turned out, this type of simple analysis which pointed to danger signs would have been more useful than sophisticated mathematical analysis that suggested the CDO's had low risk.




One of the most important errors was that independent due diligence using simple checks of the complex models were apparently not performed. Financial and legal professionals seem to like to show how smart they are by describing complicated financing structures and reciting sophisticated statistics. Many investments are made by relying on seemingly qualified outside experts to make detailed traffic studies, write complex contracts, rate intricate credits, value complicated options or perform other economic studies. In the case of housing prices, despite the clear oversupply of housing and the bubble in housing prices, prominent economic forecasters projected continued increases in housing prices and housing starts. With hindsight, given the oversupply and the high prices, neither continued housing starts nor increased housing prices could have been sustainable. The macro economic forecasts along with the rating agencies failed dramatically. No matter how much commentators bemoan the lack of transparency, it is the job of investors themselves to understand the underlying economics of any transaction. If the fundamental rational of the investment is not understood, investors should stay away; relying on so-called experts is not an excuse.

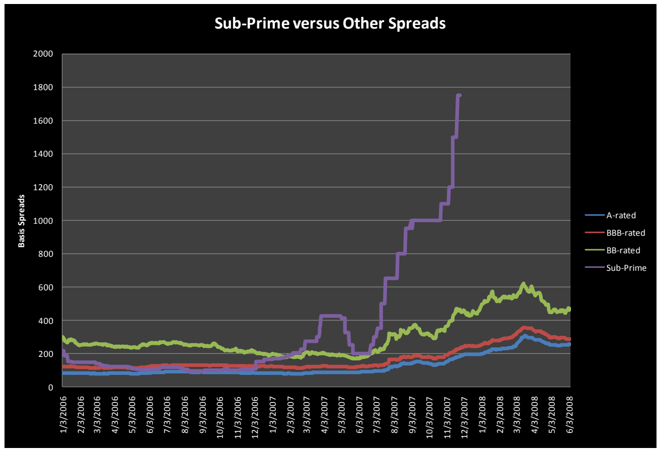


Lack of fundamental analysis was perhaps more evident in the work of the credit rating agencies. After Moody's listed its shares in 2000, its managers adopted the philosophy that it was in the service business rather providing objective information. All three of the rating agencies could earn $200,000 from providing a rating that was acceptable to bond issuers. When the housing boom was at its height, the rating agencies attempted to process a very large volume of transactions. The Financial Times quoted an analyst who had to rate a $1 billion structured deal in 90 minutes and described the Monte Carlo process used to rate the bonds: "From an ordinary desktop computer, you start the Moody's rating software. A window opens in which you set the basic assumptions: duration of bond, payment, collateral details ... and then – click – the simulation is set running. Not once, but a million times, each time with a different outcome. It's the average outcome from all those simulations that gives you a rating." Unfortunately for bondholders, there was a bug in the software. More importantly, the statistical models used to assess complex securities relied on historical patterns of default. This assumed that the past trends continue to be relevant even though sub-prime loans and other mortgages were nothing like loans made earlier. Traditional credit analysis concentrates on debt to income and evaluating downside cases. The graph below illustrates that on an aggregate basis, the debt to income dramatically increased.

Fifth, as housing prices continued to increase, many people believed that they could buy a house, hold it for a short period, and then sell it for a profit. Further, to finance the purchases, sub-prime lending could be used. Richard Bittner explained that "a surprising number of number of sub-primes went to affluent people stretching for second homes." Charles Morris describes the practice of speculating on houses as: "lenders welcomed "flippers" – people buying houses solely for the purpose of reselling in a year or so. By 2005, 40% of all home purchases were either for investment or for second homes….a large share of the "second homes" actually were speculations for resale." To some extent, this activity of re-selling homes became a self-fulfilling prophecy as the increased demand from speculation put upward pressure on housing prices. It seemed that one could make money without applying any particular unique skill and without taking risk.

It is natural to be envious of a neighbor who is making a lot of money through buying and re-selling houses using other peoples money while you are earning a meager 5% on low risk deposits at the bank or even while you are only making 15% in the stock market. One of the only things that seems to be clear about finance, however, is that unless you have some kind of real competitive advantage, increased returns do not come without increased risk. In any business endeavor, as the foundation of value is having some kind of competitive advantage and acting on the advantage. Instead, the notion of many participants in the real estate business would continually buy and re-sell homes as the price of houses increased. This practice, known as "flipping" is explained by Morris: Investors who engaged in this activity believed they could make money easily without taking risk or having some kind of competitive advantage – anybody with a little money could find a broker to make a sub-prime loan and put virtually no money down on a loan. After the financial crisis and turmoil in financial markets very few people seriously believe that markets are efficient, however markets tend to be efficient enough that the ability to make easy money with no hard work, no cost advantage, no monopoly power or no product differentiation cannot be sustained.

Sixth, with hindsight, it is apparent that investors did not recognize the non-linear nature of economic variables when investing in structured real estate projects. One of the ideas of structured products was the old notions of diversifying a portfolio. The problem is that investors focus on expected returns without paying enough attention to the skew ness of the upside and downside returns. The upside return on underlying loans was a credit and a higher margin when the loans were re-financed. The graph below shows that the upside on sub-prime loans was about the same as investment grade bonds. However, if the upside really occurred, the homeowners would re-finance, further capping the return. On the other hand, as history has shown, the downside was dramatic and is limited only by the value of the investment. The problem of not spending enough thought and analysis in evaluating the possibility and magnitude of upside and downside cases is not unique to the sub-prime crisis. This phenomena has been a problem in mergers, public policy choices, and many other decisions.




Finally, the sub-prime crisis taught that contracts are not necessarily valid if economic conditions change significantly. The famous explosion of credit default swaps that where used to assure the performance of various loans assumed that the counterparties of the swaps would not default. These default swaps are essentially the credit spread portion of a loan and should be evaluated in a similar fashion to any loan. The financial community seemed to be more concerned with creating synthetic loans (analogous to writing thousands of insurance policies on a single person and trading the insurance policies) than to performing old-fashion credit analysis and questioning the opinions of rating agencies. Synthetic credit default swaps and analogous instruments have nothing to do with real economic activity just like writing 50 insurance policies on the same person does not have any benefits to the family of the person who dies. The valuation lesson is to focus on ways to combine judgment and statistical analysis in evaluating the underlying risks of investments.

## Selected Valuation Nightmares other than the Sub-prime Crisis

The case studies presented below each isolate on one of the single valuation issues associated with the sub-prime crisis and delve into further detail. Reviewing other cases demonstrates that the problems discussed above in the context of the sub-prime crisis are in no way unique. It was simply the larger magnitude that meant errors in home mortgage lending created the financial crisis. Cases discussed include the merchant power meltdown of 2002-2003, the over-leveraging of the Eurotunnel project, excess capacity from nuclear plant construction in the 1970's, the meltdown on debt and equity values for Telecommunications companies, Enron's failure with its Dabhol plant in India, and financial fallout from the California electric power crisis. As with the sub-prime crisis, these situations also involved a toxic mixture of the valuation problems. Although many of the cases are taken from project finance transactions and the electric power and infrastructure sectors, one could easily come up with examples of dramatic mistakes in valuation have occurred in many other sectors. For example, other than real estate mortgage loans in the U.S., if one were to study the crash of many telecommunications companies in 2000 and 2001, bursting of the internet bubble, the demise of Long-term Capital management in the late 1990's, the failed merger between Chrysler and Mercedes Benz, investments made before the East Asia Crisis of 1997 and many other cases. Below the headlines of these financial disasters were very similar underlying mistakes as those which are discussed below.

Each of the valuation nightmares had effects not only on investors in the investments, but also on the general public. In the case of mis-estimating the cost of capital through not correctly estimating the debt capacity, over-investment or under-investment results in mis-allocation of resources that have important effects. In other cases, ignoring the mean reversion in prices leads in aggravating cyclicality, leading to higher volatility in prices. In other cases, consumers face higher prices or taxes to rescue the investment mistakes. In yet other cases, the mis-estimation of upside versus downside has caused power outages. Those involved in the valuations often use the term perfect storm to imply that a series of very unlikely events that could not have been reasonably predicted happened at once. This term is inappropriate and irritating once one studies the different valuation mistakes. With hindsight, most of the valuation errors were not the result of completely unpredictable events, but rather could have been foreseen with a bit of very basic economic analysis.

The case histories selected to introduce valuation issues analysis include a similar basket or mistakes as those introduced above for the subprime crisis. The cases involve one or more of the following errors:

1. Assuming that prices and volumes can continue to increase in tandem in the presence of surplus capacity.
2. Relying on experts for forecasts and valuation who do not have a financial interest in investments without verifying analysis with back of the envelope analysis.
3. Using statistical analysis on historic data without realizing the manner in which economic variables can suddenly change in non-linear ways.
4. Ignoring differences in the flexibility of alternative investments in how they react to key economic variables.
5. Believing in innovative valuation techniques that suggest easy money can be made without understanding the ultimate source of cash flow.
6. Not studying long-term marginal cost relative to prices in evaluating cash flows.
7. Making simplistic assumptions with respect to downside and upside cases rather than recognizing differences in upside potential and downside risk.
8. Assuming that contracts will protect investments without delving into the potential for contracts to be broken or mismatched.

Before considering the valuation problems, it is worth noting factors that were not very important in making the mistakes. The mistakes in valuation did not generally arise from many of the factors discussed by in the theory of finance. Pablo Fernandez published an article with a seductive title -- “110 Common Errors in Company Valuation.” He discuses how errors arise from factors such as incorrectly measuring beta, wrongly computing the tax shield on debt, and including operating as well as surplus cash in the valuation.[10] It is doubtful that any of the flawed investment decisions described below would have been solved by more accurately estimating beta or the weighted average cost of capital or more accurately separating surplus cash from operating cash.

## Case 1 – Incorrectly Assessing Risk Using Historic Trends and Volatility and the Case of AES Drax

[10] Pablo Fernandez, “110 Common Errors in Company Valuation”, Working Paper, November, 2007.

The first case study addresses valuation problems and biased risk assessment from using extrapolation of historic price data in measuring debt capacity and cost of capital. The situation discussed below -- investment choices vis-à-vis electricity plants in the U.K. merchant market – involved underestimation of risk resulting from assuming that historic price trends would continue and that future cash flow volatility would be similar to past volatility. (The merchant market means electricity plants that sell electricity into deregulated markets rather than realizing prices from long-term contracts or from regulated prices.) The valuation mistakes associated with U.K. electricity prices caused dramatic financial distress during the years 2001 to 2003 and the particular case studied involves the largest electricity plant in Europe, the Drax plant located in Yorkshire. This plant originally constructed in the 1970's was purchased by AES in 1999 and financed with a ratio of debt to capital of 90%. AES abandoned the plant in bankruptcy four years later in 2003.

For some physical risks such as wind speed, geological analysis of mining resources, solar radiation, reliability of machines or water conditions, historical analysis of statistical data can be a very good way to evaluate risks. In these cases, a reasonable probability distribution associated with historic variables can be established from the historic data. However for other variables such as the amount of traffic on a new toll road, the cost of a new and complex technology, the price of housing, the price of electricity and many other economic variables, the nature of risk is very different. In evaluating risks for these cases, history is a much less effective tool in assessing future possible dispersion of cash flow. In the case of AES Drax and the U.K. merchant market, the underestimation of electricity price volatility and particularly evaluation of downside risk from inappropriate analysis of historic data led to incorrect cost of capital assumptions and over-investment in electricity generating capacity (analogous to the over-investment in real estate that occurred in the sub-prime crisis.) The problems in assessing risk would not have been remedied by spending more time studying beta or making a lot of sophisticated mathematical analysis with Monte Carlo simulations derived from past data. Instead, the case illustrates that understanding simple economics of market structures – specifically over-capacity and decreased concentration should be the centerpiece of analysis where the most important value driver is the risk of future market prices.

The United Kingdom de-regulated its power system before any country in Continental Europe, North America or Asia in the late 1980's after the Thatcher government passed the Electricity Act of 1989 (partly in response to the famous coal miner strikes that had occurred in the country). In the initial years after deregulation, prices to consumers fell by about 30% and electric industries in other countries began to follow the lead of Britain.[11] When the market was first established in 1990, virtually all of the formerly government owned generating capacity was divided into only three companies, two of which – National Power and PowerGen – owned power plants that were privatized, while the third was a government owned company that controlled nuclear stations. Prices were set through a bidding process along with something named an administrative uplift that was intended to compensate for capacity that was available but not used.[12] Since there were only two firms in the market, many argued that prices did not reflect marginal cost but rather were set in an oligopolistic manner where the companies did not act as price takers and submit bids corresponding to their own variable cost, but rather strategically withheld capacity and engaged in other tactics to keep prices high. The stability and the level of prices in the U.K. led many investors to consider building new generating plants, particularly natural gas fired combined cycle plants.

If the structure of the U.K. market remained static (with three primary companies) and demand grew at a similar rate to new capacity additions, the historic stable prices and low price volatility would imply that investments could support a relatively high level of debt and implicitly have a low cost of capital. In the late 1990's many new plants were indeed built and they were often able to achieve high levels of debt financing. The table below lists power plants constructed or acquired and shows that many of the projects were financed with high levels of debt (data is not available for each plant because where bank debt is used, financial statements are not available to the public.) With hindsight, if the plants that did not

[11] Green Richard, Draining the Pool: Reforming the Pool of England and Wales, December1998.
[12] The administrative uplift was £2,000/MWH escalating with inflation. See Green Richard, "Did Electricity Generators Play Cornot: Capacity Withholding in the Electricity Pool," 6-April, 2004.

have fixed price long-term power contracts (i.e. were purely merchant), they could not support the 80-90% debt ratios shown on the table.[13]

| Count | Parent Company | Project Name/ Regio | Commercial Operation as MPP | MW | Project Typ | Project Co | Cost per M | Arrangers /Lende | Debt Rat |
|---|---|---|---|---|---|---|---|---|---|
| UK | AES | Barry | 1998 | 220 | Greenfield | $ 225.00 | $ 1.023 | IBJ | 90.0% |
| UK | PowerGen | Connah's Quay Power Sta | 1996 | 1420 | Greenfield | | | | |
| UK | PowerGen, ESBI | Corby | 1994 | 400 | Greenfield | | | | |
| UK | InterGen | Coryton | 2002 | 795 | Greenfield | $ 465.80 | $ 0.586 | CSFB, SG, | 70.0% |
| UK | PowerGen, Siemens | Cottam Development Cent | 1999 | 400 | Greenfield | | | | |
| UK | Entergy | Damhead Creek | 2000 | 800 | Greenfield | $ 563.00 | $ 0.704 | WDR/UBS | |
| UK | Innogy | Didcot-B | 1997 | 1400 | Greenfield | | | | |
| UK | NRG Energy, El Paso | Enfield | 1999 | 396 | Greenfield | $ 353.23 | $ 0.892 | | |
| UK | Centrica | Glanford Brigg | 2002 | 240 | Acquisition | | | | |
| UK | BP-Amoco, Arco | Great Yarmouth | 2001 | 400 | | $ 367.65 | $ 0.919 | SG, ABN A | 87.5% |
| UK | Octagon Energy | Hickleton Power Plant | 2000 | 6 | Greenfield | $ 3.79 | $ 0.631 | | |
| UK | NRG Energy | Killingholme | 1999 | 665 | Acquisition | $ 664.00 | $ 0.998 | Bank of Am | 65.0% |
| UK | Centrica | King's Lynn | 2001 | 705 | Acquisition | | | | |
| UK | Scottish and Southern Energy | Peterhead Power Station | 2000 | 660 | Restructured | $ 333.33 | $ 0.505 | | |
| UK | InterGen | Rocksavage | 1998 | 780 | Greenfield | $ 575.00 | $ 0.737 | CSFB | |
| UK | Centrica | Rooscote | 2003 | 229 | Acquisition | $ 37.50 | $ 0.164 | | |
| UK | Calpine | Saltend | 2001 | 1200 | Acquisition | $ 800.00 | $ 0.667 | WDR | 90.0% |
| UK | Scottish and Southern Energy, | Seabank | 2001 | 760 | Greenfield | $ 641.18 | $ 0.844 | | |
| UK | Scottish Power | Shoreham | 1999 | 400 | Restructured | $ 320.00 | $ 0.800 | | 93.5% |
| UK | Centrica, Humber Power | Stallingborough Plant | 1999 | 1260 | Greenfield | | | | |
| UK | London Power Co. | Sutton Bridge | 2000 | 790 | Greenfield | $ 793.00 | $ 0.695 | Merryl Lync | 87.2% |
| UK | Enron | Teesside | 1993 | 1875 | Greenfield | $ 1,200.00 | $ 0.640 | | |

Because of innovations in the technical efficiency of combined cycle gas plants – more electric power could be sold for the same amount of natural gas used -- profit could be realized from selling power at the historic prices which had ranged from $25/MWH to $30/MWH. The table below shows that power plants could be constructed at the -- then current -- cost estimates and realize relatively high returns of more than 15% as long as debt financing was available. The three columns in the table show the economics of a new gas fired electricity plant using three different price assumptions. The columns list the equity returns with different levels of debt leverage with the three different price assumptions. Equity returns below a 15% hurdle rate are colored in red on the table. With moderate levels of debt financing, the downside risk of investing in merchant plants seemed to be limited.

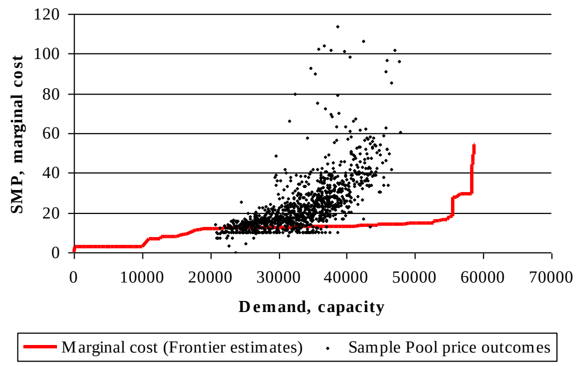
| Equity Price | 26.50 | Equity Price | 24.50 | Equity Price | 22.50 |
|---|---|---|---|---|---|
| Debt Pct | Equity IRR | Debt Pct | Equity IRR | Debt Pct | Equity IRR |
| 0.0% | 11.6% | 0.0% | 10.3% | 0.0% | 9.0% |
| 19.2% | 12.6% | 19.2% | 11.2% | 19.2% | 9.7% |
| 37.3% | 14.1% | 37.3% | 12.4% | 37.3% | 10.6% |
| 54.5% | 16.4% | 54.5% | 14.3% | 54.5% | 12.1% |
| 62.8% | 18.1% | 62.8% | 15.7% | 62.8% | 13.1% |
| 70.8% | 20.7% | 70.8% | 17.8% | 70.8% | 14.7% |
| 78.7% | 24.9% | 78.7% | 21.2% | 78.7% | 17.2% |
| 86.4% | 33.5% | 86.4% | 28.1% | 86.4% | 22.3% |
| 93.9% | 69.6% | 93.9% | 56.8% | 93.9% | 42.6% |

In constructing the new capacity and applying high debt to capital ratios to the plants, investors, and more importantly banks, made an implicit or explicit assumption that stable prices would continue. This assumption depended on limited surplus capacity and continuation of the oligopolistic market structure. With hindsight, it is clear that neither of the assumption of stable capacity relative to demand nor a continued oligopolistic market structure were sensible. Capacity was being added much faster than demand and slow demand growth in the U.K. meant that surplus capacity would last a long time as demonstrated by the table below. The increase in capacity was due to the fact that natural gas combined cycle facilities could operate profitability at pricing levels that historically existed in the market. The private power plants that were developed increased the U.K. reserve margin (the amount of capacity divided by the peak load) to more than 25%, far above the typical reserve margin criteria used in the industry of 15%.

[13] ADB database.

| UK Demand and Supply GW | |
|---|---|
| Natural Gas and Conventional | 18.5 |
| Nuclear | 1.2 |
| Total | 19.7 |
| | |
| Demand Growth | 2.7 |

The second precept required for stable prices was that the market would remain oligopolistic so that prices would not move to more volatility short-term marginal cost based prices. As with the assumption that prices could be maintained in the face of increasing capacity, this assumption was also not reasonable because of political pressures and government actions. In a report on the U.K. market, Moody's noted that "the dissatisfaction with the Pool relates essentially to the scope for manipulation that generators with significant market power enjoy under the Pool's complex rules."[14] The ability to exercise market power is demonstrated on the graph below which compares market clearing prices with the marginal cost of power. The prices at various levels of demand are shown on the black dots while the marginal cost at different levels of capacity is show on the red line (marginal cost is discussed in Chapter 7). The preponderance of clearing price being above the marginal cost is evidence that the markets were not operating in an efficient manner before U.K. markets were reformed in 2000.[15]




As a result of market power concerns and political outcry, the British Government ordered the two private companies that owned many of the power plants to divest their capacity and it changed the structure of the way prices were determined in the design of the market.[16] The reforms resulted in a system called the New Electricity Trading Arrangements (NETA) which was implemented in the spring of 2001 to "improve market information and transparency, enhance liquidity and reduce the opportunities for the exercise of market power by generators." [17] After reforming the market, the relative share of ownership in the market change dramatically. The difference in concentration of firms is shown in the graph below before 1999 and after 2000.[18] In addition, the rules determining uplift charges, bidding, and the power pool were revised. Developers and bankers complained that the new market system changed the rules in the middle of the game and were extremely unfair to generation suppliers. However it is arguable that bankers and investors with foresight could have seen that the system in place before 1999 was not

[14] Moody's reference

[15] The graph is from a presentation by Philip Burns of Frontier Economics in London, October 12, 2000. "The Implications of Regulation and Competition for Corporate Activity."

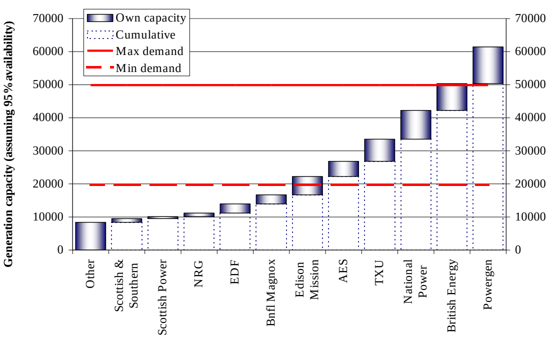
[16] Find Reference

[17] DRAX SEC 10-k

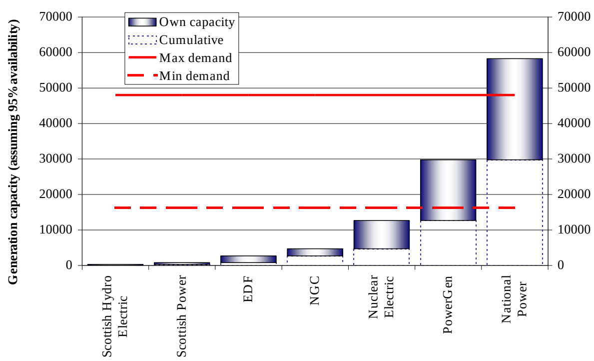
[18] The graph is from a presentation by Philip Burns of Frontier Economics in London, October 12, 2000. "The Implications of Regulation and Competition for Corporate Activity."

sustainable politically – implying the historic trends and volatility in prices did not provide much guidance for prospective prices.

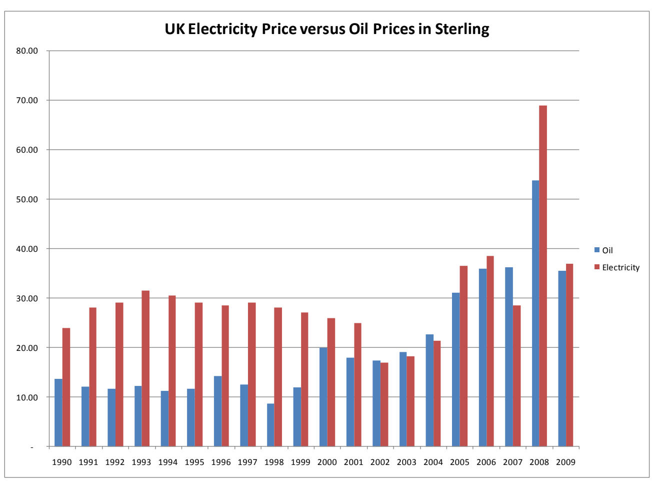
**After Reforms**




**Before Reforms**




Given the changed market structure and the increased capacity, statistical analysis of historic prices was irrelevant in valuation analysis. Furthermore, with a more atomized structure plants become price takers and prices can move all the way down to short-run marginal cost – the variable running cost of plants "on the margin." Changes in the structure of regulation and the over-capacity caused market clearing prices to change dramatically. Before the market reforms, the annual volatility in prices was small and the level of prices remained flat. However after the addition of capacity and the atomization of plant ownership, prices declined dramatically as shown on the graph below[19]. The graph demonstrates that for the first decade that the market operated, prices were essentially constant at £25/MWH[20] while they declined to about £17/MWH in 2001. According to a 2003 US Energy Information Agency report: "[w]hile restructuring of the electricity industry was intended to end market abuses by large electricity generators and increase the market's efficiency, the system has been so successful that in the last four years, prices have decreased by about 40%."[21] The graph demonstrates that the decline in prices was particularly dramatic when viewed in the context of primary energy prices.

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[19] From Hugh Outhred, "Global trends in electricity markets", School of Electrical Engineering and Telecommunications The University of New South Wales Sydney, Australia

[20] Moody's report on Drax, 2000.
[21] www/eia.us.gov, 2003

When banks evaluated the level of debt that was supportable, they used forward market prices studies performed by consultants who provided forecasted price levels and ranges over long-periods of 20 years or more. With hindsight these studies performed by firms with no financial interest in the pant did not predict actual declines in electricity price that occurred. The following statement made by the rating agency Moody's in reference to a study prepared by a consulting company named Camus for the AES transaction in 1999 illustrates the mistakes: "we do not expect … a sudden and marked fall in wholesale electricity prices in England and Wales." While many plant owners complained about the NETA market rules, the underlying reason for price declines and volatility were overcapacity and reduced market concentration. A financial report of AES Drax, the subject company discussed below, summarized this as follows: "Although NETA has impacted electricity prices, NETA has not generally been considered to be the principal underlying cause behind the decline in UK power prices; this is more likely due to the over-capacity in the UK generation market, increased competition and fragmentation of the market." [22] With the new market structure future price volatility and price trends could not have been predicted from historic volatility and price trends. The price declines caused by overcapacity were by no means limited to the U.K market. As stated above in the very first paragraph of this chapter, by one count, the merchant power industry lost $100 billion in market value in the early years of the 21$^{st}$ century. With hindsight, the changes in prices were predictable and the debt leverage was far too high for the plants.

While the financial situation of the plants have recovered, because of price declines in the years 2001-2004, many of the plants that were not supported by a contract were either bankrupt or in a state of serious financial distress. According to one commentator "less than ten years after the privatization of the electricity industry, the energy market has effectively gone bust."[23] Banks had lent high levels of debt to the projects apparently without fully considering the potential for changes in the trends and volatility of prices – implying that the cost of capital was relatively low for these investments. The errors made in risk assessment implicitly resulted in incorrect cost of capital which in turn lead to over-investment and financial distress. Had lenders made better estimates of debt capacity through realistically assessing the volatility of power prices and the potential for over-supply rather than simply using historic projections, investors would have made more rational investment decisions. The actual price volatility from a changed market structure demonstrates that risk and cost of capital was much higher than the cost of capital implicit in the high debt financing that occurred. The changed structure of the market meant that historic data was almost useless in projecting future trends. The potential variation and trends in future prices should have explicitly recognized the surplus capacity as well as the movement away from oligopolistic pricing.

The AES Drax in Yorkshire was one of many plants that experienced financial problems and illustrates the valuation mistakes made by investors and credit analysts in the U.K. power industry. AES is a large holding company that owns plants around the world and it had decided to let a merchant plant in Wales named the Fifoots plant enter into receivership because of the low power prices. According to AES, the plant was "no longer possible to sell power above its marginal cost of generation."[24] Drax, a 3,960 MW station commissioned in two parts in 1974 and 1986, is the largest coal plant in Europe. In mid 1999, the plant was purchased by AES from National Power (renamed Innogy) for £1,963 million (the plant sale was driven by the government ordered divestitures associated with reducing market concentration discussed above.) The purchase price converted to a cost of US$758/kW – higher than the cost of an efficient new combined cycle plants that were typically dispatched ahead of coal plants in the U.K. market because of their lower marginal cost. In financing the plant, AES injected £224 million of its own equity, resulting in a debt to capital ratio of about 90%. The debt consisted of bonds which initially carried an investment grade rating of Baa2 by Moody's. A summary of the capital structure is shown on the table below. The bank debt carried a credit spread of 165 basis points and had a tenor of 15 years.

[22] AES 10-k Report for the year ended 12 December 2002, page 16.
[23] Britain's privatized energy industry on brink of bankruptcy By Jean Shaoul, 23 October 2002
[24] AES 10-k, page 17.

| | GBP Millions | Percent |
|---|---|---|
| AES DRAX Holdings Limited Bonds | 400.00 | 18.2% |
| AES DRAX Energy Senior Notes | 267.00 | 12.1% |
| In Power Bank Facility | 1,308.00 | 59.5% |
| Equity | 224.00 | 10.2% |
| Total Capitalization | 2,199.00 | 100.0% |

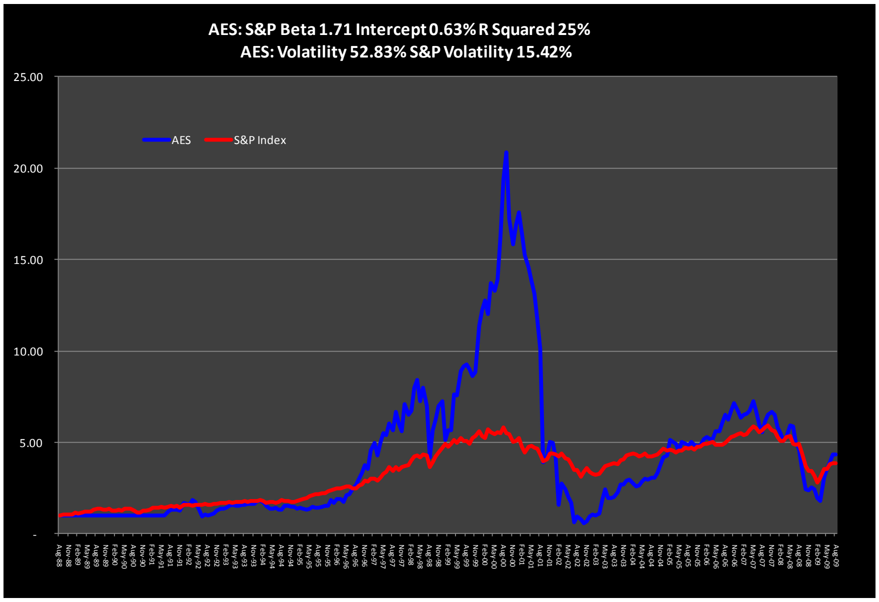
**Financial Projections**

| | Caminus Base Case | Caminus Low Case | Collapse Case (a) | 50% Load Factor yr. 7 | Reduced Plant Eff. | Reduced Availability |
|---|---|---|---|---|---|---|
| **After Tax Operating Company ADSCR** | | | | | | |
| Average ADSCR (1-15) | 1.72x | 1.50x | 1.48x | 1.61x | 1.66x | 1.61x |
| Minimum ADSCR (1-15) | 1.42x | 1.27x | 1.20x | 1.35x | 1.36x | 1.19x |
| Average ADSCR (16-25) | 5.11x | 4.22x | 4.15x | 4.45x | 4.96x | 4.61x |
| Minimum ADSCR (16-25) | 3.76x | 3.09x | 2.86x | 3.29x | 3.65x | 3.40x |
| Average ADSCR (1-25) | 3.05x | 2.57x | 2.32x | 2.73x | 2.96x | 2.79x |
| Minimum ADSCR (1-25) | 1.42x | 1.27x | 1.20x | 1.35x | 1.36x | 1.19x |
| **After Tax Holding Company ADSCR** | | | | | | |
| Average ADSCR (1-10) | 3.09x | 2.29x | 1.89x | 2.94x | 2.81x | 2.75x |
| Minimum ADSCR (1-10) | 2.13x | 1.48x | 1.13x | 2.01x | 1.74x | 1.00x |
| **After Tax Consolidated ADSCR** | | | | | | |
| Average ADSCR (1-10) | 1.33x | 1.21x | 1.15x | 1.31x | 1.29x | 1.26x |
| Minimum ADSCR (1-10) | 1.20x | 1.08x | 1.00x | 1.14x | 1.13x | 1.00x |
| Average ADSCR (16-25) | 4.82x | 3.98x | 3.93x | 4.20x | 4.68x | 4.35x |
| Minimum ADSCR (16-25) | 3.03x | 2.53x | 2.32x | 2.70x | 2.93x | 2.74x |
| Average ADSCR (1-25) | 2.74x | 2.31x | 2.09x | 2.45x | 2.66x | 2.51x |
| Minimum ADSCR (1-25) | 1.20x | 1.08x | 1.00x | 1.14x | 1.13x | 1.00x |
| **Moody's DTBE Analysis** | | | | | | |
| **Merchant Revenue DTBE** | | | | | | |
| Year 1-15 Average | 34.2% | 26.2% | 22.0% | 32.8% | 31.5% | 29.8% |
| Year 15-25 Average "Merchant Period" | 34.8% | 30.5% | 28.0% | 33.4% | 34.0% | 32.5% |
| Year 1-25 Average | 34.6% | 28.0% | 24.6% | 33.2% | 32.6% | 30.9% |

The bond rating of AES Drax was in part dependent on a contract the company signed with a company named TXU Europe for 50%-60% of the plant capacity for 15 years. One of the contract provisions mandated that AES Drax maintain an investment grade rating. Further, the financial status of TXU Europe depended on continued high market prices. After the price declines and a bond downgrade, TXU Europe terminated its contract in November 2002 and TXU Europe subsequently declared bankruptcy. This left AES Drax operating on a fully merchant basis. According to AES Drax financial reports, "The initial assumptions on which the AES Drax companies relied when making the original investment assumed that it would have the protection of its long-term Hedging Contract with TXU Europe and that electricity prices would remain at a certain level. Since we acquired the Drax Power Station electricity prices have declined on average by approximately 40% and in November 2002 our Hedging Contract with TXU Europe was terminated and the TXU group entered into administration." After not meeting debt service obligations, AES effectively abandoned the plant in August 2003.[25] The table below illustrates the time line of AES Drax and the effects on the stock price of AES Corporation.

The financial problems with DRAX were one of the reasons AES experienced a dramatic decline in its stock price as shown in the graph below.

[25] BBC Report




The case demonstrates that debt capacity does in fact affect investments – much more than the estimated cost equity of capital derived by someone making statistical analysis of beta in the CFO's office. Mistakes in valuation occur because trends and the volatility of operating cash flow is not gauged correctly by bankers. Here, the volatility of operating cash flow changed from historic levels and this change was not included in the analysis. The theory of using debt capacity in project finance to derive the cost of capital is discussed in Chapter 4. Practical and theoretical problems with the CAPM are first described. Then, use of debt capacity as a tool to objectively quantify is discussed.

| AES DRAX Operating Data and Interest Payments | | | | |
|---|---|---|---|---|
| | **2000** | **2001** | **2002** | **9 Mos 2003** |
| Operating Profit | 174,523.00 | 143,404.00 | 115,843.00 | (94,780.00) |
| Interest | 153,325.00 | 166,011.00 | 175,444.00 | 137,670.00 |
| Difference | 21,198.00 | (22,607.00) | (59,601.00) | (232,450.00) |
| Capacity Factor | 66.48% | 64.40% | 56.30% | 63.23% |

This case demonstrates that real investment decisions and cost of capital decisions do depend on debt capacity assessments made by banks. The mistakes in this case came from not realizing that prospective volatility in cash flows would be far higher than historic volatility. It is not suggested that a more accurate estimation of Beta and weighted average cost of capital could have solved anything, but rather that the credit analysis process is central to valuation. Risks of changes in trends and volatility of future prices highlight issues of whether risk can be derived from credit analysis and dangers in assuming returns substantially above the cost of capital can be earned in markets with few barriers to entry. The discussion addresses whether it is effective to use debt capacity to derive risks associated with forward price projections.

| AES Drax Timeline | |
|---|---|
| AES Purchased DRAX from Innogy | 15-Aug-99 |
| NETA Replaces Pool | 27-Mar-01 |
| Fifoots Plant Placed in Receivership | 1-Mar-02 |
| Downgraded from Baa3 to B3 | 14-Oct-02 |
| TXU Sells Assets to E.ON | 21-Oct-02 |
| TXU Stops Contract because of Downdrade | 4-Nov-02 |
| TXU Declares Bankruptcy | 1-Nov-02 |
| Moody's Downgraded to Caa3 | 7-Nov-02 |
| Standstill Agreement with Creditors | 13-Dec-02 |
| AES Abandons Drax | 1-Aug-03 |

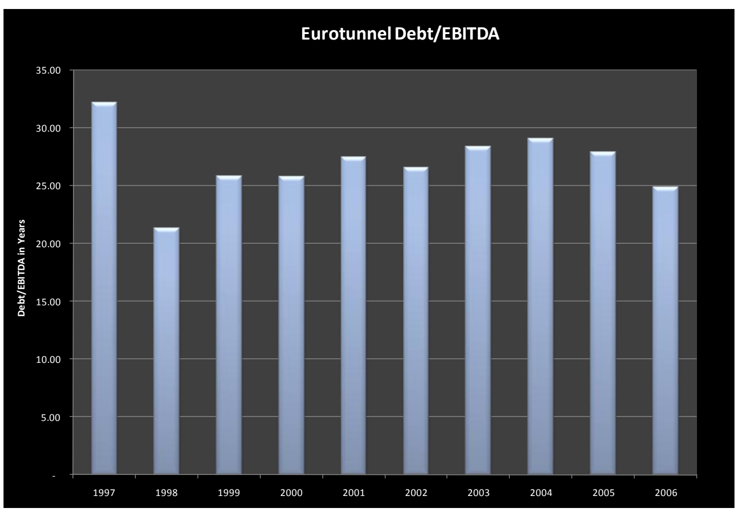
While debt capacity analysis can be useful in valuation, it remains prone to mistakes because the level of risk and amount of debt may incorrectly assessed by lenders. If debt capacity can be used to measure overall risk of an investment, then mistakes made by lenders and credit rating agencies translate into poor investment decisions. One of the problems in using the risk assessment by lenders is that bankers, who are anxious to earn fees, convince themselves to believe forecasts that are not sensible. Further, risk assessment mistakes are compounded because after one major bank accepts the risk of a loan, if analysts at a second bank question the efficacy of the analysis, they are scoffed at. Suppose you are a credit analyst at a relatively small bank – ABC bank – and you believe there is too much risk for the suggested level of debt. A typical conversation may be that if Citibank and HSBC determined that a loan is an acceptable risk, who are you to say that you do a better analysis than such a very sophisticated bank. The case of project financed power plants in the United Kingdom illustrates how debt capacity in transactions can be used to quantify risk and how debt capacity assessment mistakes can lead to over-investment and incorrect valuation.

Chapter 3 and Chapter 4 attempt to address the issue – get around bankers by assessing risk through independent mathematical analysis. Use the good part of assessing volatility, but simulate the volatility instead of relying on the analysis of others. This gets around two problems, first the problem with cost of capital and beta and second, the problem of using bankers.

## Case 2 - Optimism Bias and the case of Eurotunnel

The second case study addresses valuation errors from biases that can arise in key estimating economic drivers from variables in which no historic data exists. The situation discussed in the paragraphs below involves the mistakes that were made by bankers, investors and managers when constructing and financing the famous Eurotunnel Project between England and France. Many of the valuation mistakes arose from over-reliance on reports and opinions of experts rather than stepping back and evaluating simpler ways to consider the potential downside in assumptions related to construction cost and traffic revenues. Reviewing Eurotunnel prompts the question of how seemingly obvious assumptions (with hindsight, of course) could have been overlooked by highly sophisticated lenders, equity investors and project developers. The 31 mile (50 km) tunnel is the largest undersea tunnel in the world; it took seven years to construct (it was supposed to take five); the tunnel was originally expected to cost £4.5 billion when construction began in 1986 and its ultimate cost rose to about £10 billion.[26] Traffic projections made by two of the most reputable firms that make traffic forecasts – Wilbur Smith and Associates and Setec – predicted revenues that turned out to about twice actual levels. Optimistic estimates of the construction cost, the timing of project completion, traffic volumes, and political support make the Eurotunnel project a poster child for what the U.K. calls optimism bias and the Standard and Poor's statement that: "[f]inancial projections …are probably inherently skewed toward successful results...hiding the true technical and operating risks inherent in many projects..."[27]

When it was completed in 1994 and to this day, Eurotunnel was the largest infrastructure project finance transaction ever completed. The project began with great fanfare regarding returns as well as the technical aspects of the project. Attempts to build a fixed line across the channel had been discussed for centuries and because of the political philosophy of the Thatcher Administration, Eurotunnel would be built "without a public penny." Advertisements for buying stocks in Eurotunnel suggested investors could earn a rate of return (an IRR) of more than 18%. While Eurotunnel never officially went bankrupt, it has had severe financial problems from the time of its opening until it eliminated much of its debt in 2007. The graph of debt relative to income shown below – specifically debt divided by EBITDA -- summarizes the financial distress of the project.




[26] There was a longer tunnel completed in Japan in 1988, but that tunnel was not as long under water as Eurotunnel. The tunnel in Japan took 17 years to construct compared to 8 years for Eurotunnel. Bonnanza, Partick, "Eurotunnel Le Hold-up Program", Editions Generals First, 1996, page 27.

[27] Find Standard and Poor's

To demonstrate the meaning of Eurotunnel's debt to EBITDA ratio of above 20 times, consider a simple analysis of how the ratio of Debt/EBITDA corresponds to debt service coverage. The table below shows this analysis by presenting debt service coverage at different levels of debt to EBITDA with different tenors of debt.[28] To read the table, look at the row with a debt tenor of 30 years. With this debt term, a debt to EBITDA ratio below than 10 times – less than one half of the Eurotunnel level -- is required to pay debt service. To put the Eurotunnel numbers in perspective, the ratio of debt to EBITDA reached levels as high as 7 times in aggressive leveraged buyout transactions at the height of the private equity boom. The table also shows that even if the debt tenor is extremely long (the concession period for Eurotunnel has been extended to 99 years), a debt to EBITDA level of above 12 times means debt service cannot ever be repaid. Eurotunnel's Debt/EBITDA ratios demonstrate there was no chance whatsoever that the project could repay its loans. (It also shows that debt to income ratios are far more relevant than debt to capital ratios as the debt to capital ratio for the project of about 80% was in line with other projects that had no problem paying off their debt.)

**Ability to Pay Back Debt -- Debt Service Coverage -- with Different Terms at 7.00% Interest Rate**

| | | Debt/EBITDA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2.0 x** | **4.0 x** | **6.0 x** | **8.0 x** | **10.0 x** | **12.0 x** | **14.0 x** | **16.0 x** | **18.0 x** | **20.0 x** |
| Term of Debt (Yrs) | **50 Yrs** | 5.56 | 2.78 | 1.85 | 1.39 | 1.11 | 0.93 | 0.79 | 0.69 | 0.62 | 0.56 |
| | **45 Yrs** | 5.42 | 2.71 | 1.81 | 1.36 | 1.08 | 0.90 | 0.77 | 0.68 | 0.60 | 0.54 |
| | **40 Yrs** | 5.26 | 2.63 | 1.75 | 1.32 | 1.05 | 0.88 | 0.75 | 0.66 | 0.58 | 0.53 |
| | **35 Yrs** | 5.07 | 2.54 | 1.69 | 1.27 | 1.01 | 0.85 | 0.72 | 0.63 | 0.56 | 0.51 |
| | **30 Yrs** | 4.84 | 2.42 | 1.61 | 1.21 | 0.97 | 0.81 | 0.69 | 0.60 | 0.54 | 0.48 |
| | **25 Yrs** | 4.55 | 2.27 | 1.52 | 1.14 | 0.91 | 0.76 | 0.65 | 0.57 | 0.51 | 0.45 |
| | **20 Yrs** | 4.17 | 2.08 | 1.39 | 1.04 | 0.83 | 0.69 | 0.60 | 0.52 | 0.46 | 0.42 |
| | **15 Yrs** | 3.66 | 1.83 | 1.22 | 0.91 | 0.73 | 0.61 | 0.52 | 0.46 | 0.41 | 0.37 |
| | **10 Yrs** | 2.94 | 1.47 | 0.98 | 0.74 | 0.59 | 0.49 | 0.42 | 0.37 | 0.33 | 0.29 |
| | **5 Yrs** | 1.85 | 0.93 | 0.62 | 0.46 | 0.37 | 0.31 | 0.26 | 0.23 | 0.21 | 0.19 |

The Eurotunnel project includes many classic valuation issues in addition to the focus of applying optimistic assumptions from consultant studies related to construction costs and traffic projections. These problems included distorted incentives because of the corporate structure, limited experience and reputation of equity investors, conflicts with the government and use of unconventional equipment:

> First, a consortium of ten construction companies named TML that owned the majority of the shell company that was created for bidding on the concession. This shell company signed construction contracts even though TML eventually only owned a tiny fraction of investment, presenting a dramatic conflict of interest. Problems with the construction contracts led to many construction over-runs and delays.
>
> Second, the equity providers (mainly small French investors) did not have the wherewithal to evaluate the project economics provide assurance that somebody who gets paid after lenders could check the key valuation assumptions. With hindsight, partially because of weak sponsors, the managers of Eurotunnel neither negotiated effectively with bankers nor with TML nor did they seem to have the best interests of shareholders in mind.
>
> Third, relationships between Eurotunnel and the governments of Britain and France were not aligned properly. Even though the project was directly related to the government activities – government owned railways operated the trains, the 55 year concession period was defined by the government, the project was awarded by the government, and the government defined the safety requirements, there was no direct or indirect financial support from the French or British governments.

[28] Analysis underlying the numbers simplifies the real world because they does not include taxes that must be paid, working capital requirements associated with EBITDA or on-going capital expenditures that must be made to keep maintain EBITDA. If these additional items were included, the debt service coverage would be lower for each level of debt to EBITDA.

> Fourth, the complexity of the ventilation systems, the shuttles, the toll plazas, the electricity requirements and other items introduced risk that could not be gauged by evaluating the cost and performance of other projects.[29]

At the heart of any valuation problem including assessment of the credit quality of loans is an outlook for key economic assumptions. Investors must read consultant reports and understand the flaws and possible problems with assumptions. Perhaps the biggest mystery of the Eurotunnel story is why 225 different banks agreed to lend money to the project on the basis of a traffic forecast, a construction cost estimate and government support which with hindsight, were completely unreasonable. As construction and financing of the project progressed, lenders, Eurotunnel management and equity investors relied on the opinions of experts rather than using their own business judgment to question the basic logic of the assumptions. In his book on Eurotunnel, Patrick Bonazza summarized problems with relying on mathematical models and consultants: "Cette histoire montre a quel point il est dangereux de confire son destin a des model mathématiques." (This story shows at what point it is dangerous to confide one's destiny to mathematical models.) He notes that Eurotunnel managers had a tendency to hide behind consultants who write complicated reports and who have no money invested in the project. Reliance on traffic consultants and engineering experts is similar to the way investors in CDO's hid behind rating agencies in the sub-prime crisis rather than considering the obvious possibility of a major decline in housing prices. We now know that rating agencies had distorted incentives as they were paid by investors (Moody's employees went on parachuting trips with clients); they did not have the staff to evaluate the volume of CDO's; their sophisticated mathematical models had bugs; and they had to develop ratings of $1 billion issues in a few hours.

Some assumptions in many valuations can be verified by physical observations and statistics such as variables related to the weather or geological analysis. Other assumptions can be evaluated by examining historical data such as reviewing price, demand and cost history. A third class of assumptions like the construction cost estimates for a unique facility and traffic projections for a new project are the most difficult to evaluate. For this type of assumption, where one cannot use technical analysis or past data, there is a tendency to use reports written by consultants and other experts. Relying on so-called experts means that one does not have to argue about things which are very difficult to predict such as when will a recession end, what the oil price will be in two years, or the construction cost and traffic projections for Eurotunnel. Many mistakes come from accepting studies without question and not applying simple back of the envelope models to check the conclusions of experts and from not applying enough downside variation to the consultant reports. Throwing multiple regressions, Monte Carlo simulation, complex economic models at a problem most of the time does not result in better valuations than stepping backing and using a simple model.

The optimism bias in constructing assumptions for Eurotunnel – and many other valuation nightmares – can be separated into different risk analysis stages and categories (see Chapter 3). To review Eurotunnel, optimism biases during two stages are considered. The first bias occurred during the construction when naïve estimates of cost and scheduling were made. Investigation of the second stage discusses why more careful evaluations of projected traffic were not developed by banks and equity investors. The construction cost estimates were developed by the construction contractor TML who in turn hired many consultants. As mentioned above, the traffic projections were developed by well respected consulting firms.

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Many aspects of the constructing Eurotunnel were unique and complex. Other than being the longest undersea tunnel, the toll plazas were the most sophisticated in the world; the rail shuttles required more safety equipment and power than any others; the terminals in England and France resembled small airports; and the ventilation and cabling were more sophisticated than other projects. Despite all of these unique aspects of the project, the construction estimates were prepared rather quickly because of timing of the original proposal (about six months.) As with most projects, the cost estimates were made by detailed engineering analysis. Given a general tendency for complex projects to experience cost over-runs as well as scheduling delays, the idea that the project could experience problems should not have been a surprise. However, the contingencies for cost-overruns were not addressed well in financing and planning of the project. Construction contracts left Eurotunnel rather than TML paying for the increased costs. Agreements with the government of the United Kingdom and France were not flexible with respect to increased costs. Management of Eurotunnel did was not able to manage the relationship with TML to reduce costs of the project.

The construction over-runs and delays for the project were massive. A good way to summarize a project such as Eurotunnel during the construction phase is to examine where the money goes and where it comes from – a uses and sources statement. This analysis is shown below for the original construction estimate and the actual experience.[30] Comparison of the two schedules shows that the primary cost over-runs were not in tunneling where tests had been made and the constructors had vast experience; they were instead in the fixed equipment including the rails, the cables, the shuttles, the toll equipment, the terminals and other equipment. The management of Eurotunnel went to war with the construction companies over the construction contracts, but it continued to insist on only buying premium equipment. For tunneling costs (representing roughly 50% of overall costs), TML was only responsible for 30% of cost overruns. Worse, TML's contribution to cost over-runs was capped at a maximum of 6% of the target cost. Eurotunnel had to pay 100% of any cost overruns over this cap. For non-tunneling costs, Eurotunnel agreed to pay all of the cost over-runs. Resolution of the disputes between Eurotunnel and TML generally favored TML. In the end, as shown in the two schedules below, the cost over-run was 117%.

**Eurotunnel Uses and Sources of Funds £ Millions - Original Estimate**

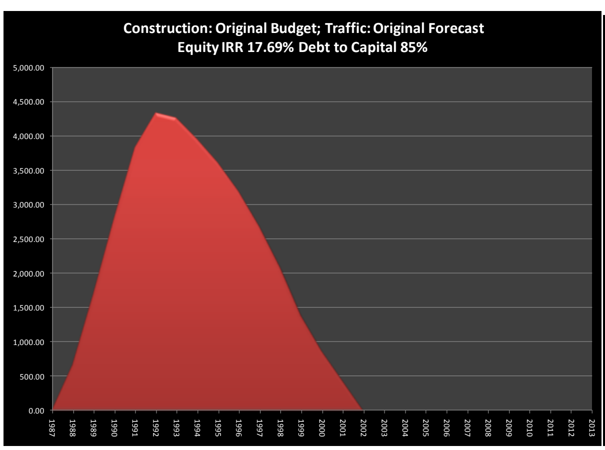
| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Total | Percent |
|---|---|---|---|---|---|---|---|---|---|
| **Uses** | | | | | | | | | |
| ***Capital Expenditures*** | | | | | | | | | |
| Tunnels | 74 | 226 | 480 | 480 | 480 | 405 | 113 | 2,182 | 47.4% |
| Terminals | 25 | 76 | 162 | 162 | 162 | 136 | 38 | 736 | 16.0% |
| Fixed Equipment | 38 | 117 | 248 | 248 | 248 | 210 | 58 | 1,130 | 24.6% |
| Rolling Stock | 14 | 42 | 88 | 88 | 88 | 75 | 21 | 402 | 8.7% |
| **Total** | **150** | **460** | **978** | **978** | **978** | **825** | **230** | **4,600** | **100.0%** |
| **Sources** | | | | | | | | | |
| ***Bank Loans*** | | | | | | | | | |
| Original Commitment (5 billion) | | | 818 | 978 | 978 | 825 | 230 | 3,830 | |
| Total Loans | - | - | 818 | 978 | 978 | 825 | 230 | 3,830 | 83.3% |
| ***Equity Issue*** | | | | | | | | | |
| Founding Shareholders (TML) | 46 | | | | | | | | |
| Institutional Investors | 206 | | | | | | | | |
| First Public Floation (Nov 87) | | 770 | | | | | | | |
| Total Equity Issuance | 252 | 770 | - | - | - | - | - | 770 | 16.7% |
| **Total** | **252** | **770** | **818** | **978** | **978** | **825** | **230** | **4,600** | **100.0%** |

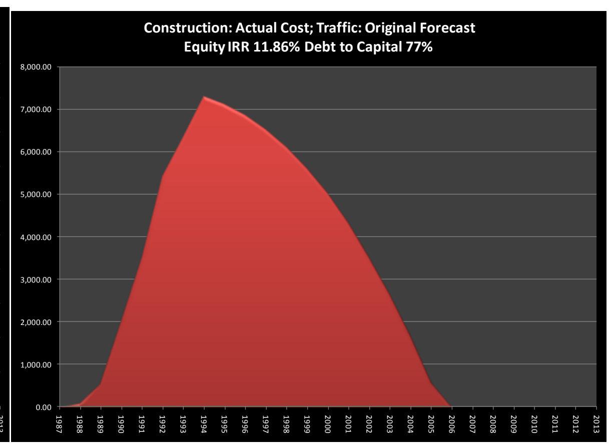
30 The numbers are derived from historic Eurotunnel balance sheets and an estimate of cost increase components.

**Eurotunnel Uses and Sources of Funds £ Millions - Actual**

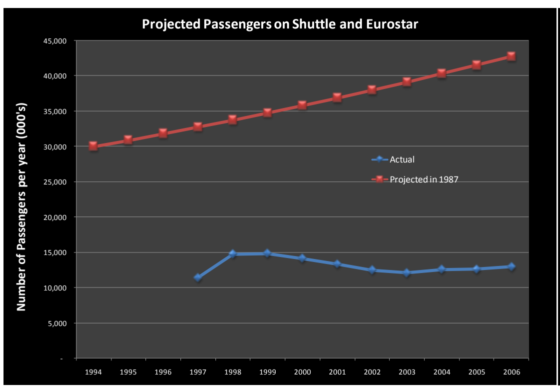
| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | Total | Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Uses** | | | | | | | | | | | |
| ***Capital Expenditures*** | | | | | | | | | | | |
| Tunnels | 69 | 254 | 114 | 439 | 609 | 582 | 720 | 578 | 218 | 3,584 | 35.8% |
| Terminals | 18 | 67 | 30 | 115 | 160 | 153 | 189 | 152 | 57 | 939 | 9.4% |
| Fixed Equipment | 39 | 145 | 65 | 250 | 346 | 331 | 409 | 329 | 124 | 2,038 | 20.3% |
| Rolling Stock | 23 | 85 | 38 | 147 | 203 | 195 | 240 | 193 | 73 | 1,198 | 11.9% |
| Total Direct Costs | 150 | 551 | 247 | 951 | 1,318 | 1,261 | 1,558 | 1,252 | 471 | 7,759 | 77.4% |
| ***Other Uses*** | | | | | | | | | | | |
| Working Capital | 102 | 221 | (78) | (105) | 403 | (328) | (278) | (167) | 483 | 253 | 2.5% |
| Deferred Expenses | | | - | - | - | - | 11 | 146 | 151 | 308 | 3.1% |
| Capitalised Interest | - | 0 | 7 | 47 | 128 | 218 | 321 | 444 | 537 | 1,702 | 17.0% |
| **Total** | **252** | **772** | **176** | **893** | **1,849** | **1,151** | **1,612** | **1,675** | **1,642** | **10,022** | **100.0%** |
| | | | | | | | | | | | |
| **Sources** | | | | | | | | | | | |
| ***Bank Loans*** | | | | | | | | | | | |
| Senior Loans | | | | | | | | | 693 | 693 | |
| Original Commitment (5 billion) | | 2 | 175 | 887 | 1,278 | 1,140 | 1,518 | | | 5,000 | |
| Additional Commitment (1.8 billion) | | | | | | | 86 | 1,672 | 102 | 1,860 | |
| Total Loans | - | 2 | 175 | 887 | 1,278 | 1,140 | 1,604 | 1,672 | 795 | 7,553 | 75.4% |
| ***Equity Issue*** | | | | | | | | | | | |
| Founding Shareholders (TML) | 46 | | | | | | | | | | |
| Institutional Investors | 206 | | | | | | | | | | |
| First Public Floation (Nov 87) | | 770 | | | | | | | | | |
| Second Public Flotation (Nov 90) | | | | | 566 | | | | | | |
| Third Public Floation (May 94) | | | | | | | | | 816 | | |
| Total Equity Issuance | 252 | 770 | - | - | 566 | - | - | - | 816 | 2,404 | 24.0% |
| Turnover | | - | 1 | 6 | 5 | 11 | 8 | 3 | 31 | 65 | |
| **Total** | **252** | **772** | **176** | **893** | **1,849** | **1,151** | **1,612** | **1,675** | **1,642** | **10,022** | **100.0%** |

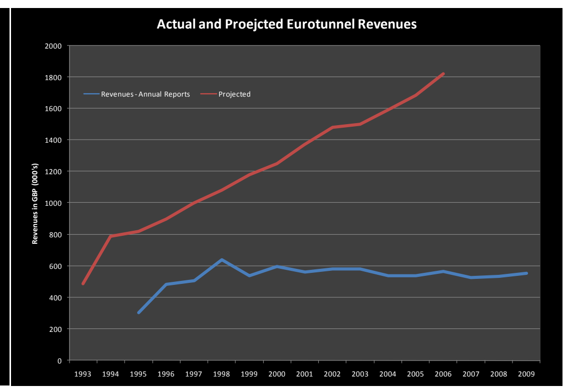
Eurotunnel paid for the construction over-runs with a mixture of debt and equity. The original loan commitment which had a buffer of 25% was fully funded; an additional debt commitment was obtained and senior debt was issued in 1994. Further, additional issues of equity from selling shares were made in 1990 and 1994. The most controversial aspect of the financing was the issuance of the final equity of £816 million just before the project opened for traffic and a few months before it could not pay interest on its debt. This equity issue came from small investors (mostly in France) and projected rosy traffic projections. Notwithstanding all of the construction problems, the analysis below demonstrates that had the revenue forecast been realized, the project could have performed reasonably well from a financial perspective. The two graphs below show financial results of the project assuming no construction over-runs and with the actual over-runs and the scheduling delays. While the cost over-run caused the equity return to fall from 18% to 12%, the debt could still be repaid well before the 55 year concession as long as traffic projections made by Eurotunnel would have been realized.



The second major assumption that turned out to be optimistic was the traffic estimates. Many infrastructure projects such as the Eurotunnel depend on a traffic study that projects the volume of sales that will be experienced. Airport revenues depend on the number of passengers; toll roads depend on the number of drivers; theme parks depend on the number of people who go through the turn-style, and the Eurotunnel depended on the amount of commercial and non-commercial traffic that would choose to pay travel between England and France in a tunnel underneath the channel. Traffic studies are essentially market share projections. The most difficult element is coming up with how much traffic will be diverted from other possible methods of traveling from one point to another. Unlike most other economic variables where analysis can be made of historic data, traffic projections must be made from a blank slate using surveys, assessment of how the speed limit will affect travel and econometric analysis of how much money people are willing to pay to reach their destination faster. The traffic studies used by Eurotunnel to arrange financing turned out to be three times more than the actual level of traffic realized and resulted in actual revenues that were a fraction of the projected revenues as shown in the table below. For example, in 1999, actual revenues of £654 million were only 56% of the £1,158 million projected in the original 1987 prospectus. For earlier years, the errors were even higher. According to David Freud of Warburg, the investment house which sold Eurotunnel shares to the public: "we were predicting that on Eurostar there would be 21 million passengers annually." The actual figure was less than a third of that. Another analyst noted that "So the traffic forecasts were not just out by a little bit. They were completely potty; they were nowhere."[31] The graphs below which compare actual passenger traffic and revenue projections to the 1987 forecasts show that the starting points of the traffic and revenue projections were completely wrong as were the growth rates.




Eurotunnel has by no means been the only project to underestimate traffic. Actual traffic levels have been dramatically different than traffic forecasts for many toll roads and for other projects such as Eurodisney. In 2002 JP Morgan completed a study of toll roads which complied the actual traffic relative to the projected traffic for a number of different toll roads in the U.S.[32] The study demonstrated that for roads which were not built in areas with existing traffic congestion where it was hoped that the road itself would lead to increased business activity and traffic, the amount by which traffic was overestimated ranged from 10% to 80%.[33] The graph below summarizes the JP Morgan analysis and demonstrates the clear tendency of the traffic studies to be dramatically over-optimistic. This study did not delve into the econometric equations used by the economists who performed the traffic study; it simply computed the actual versus forecasted levels. The natural question analysts should ask about prospective toll roads is why similar traffic errors will not occur.

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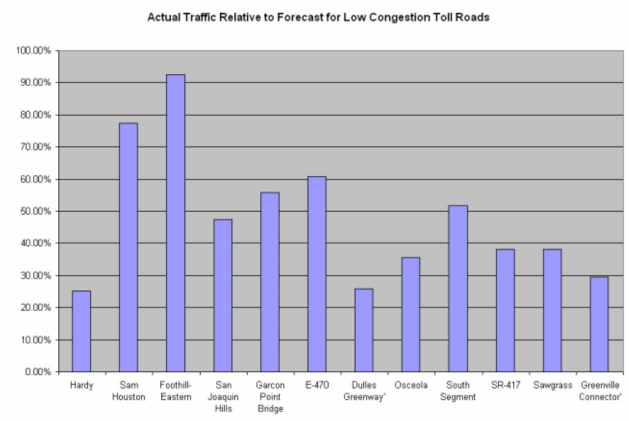
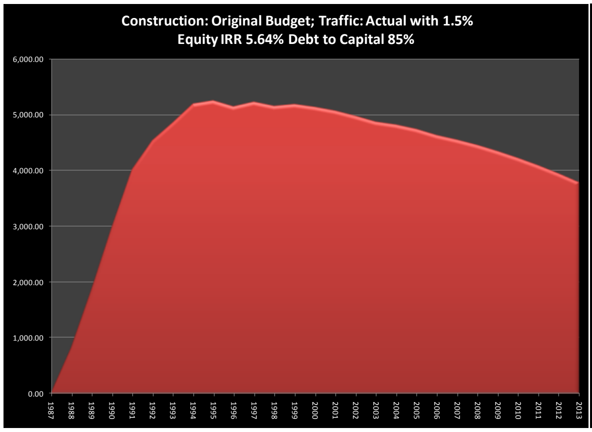
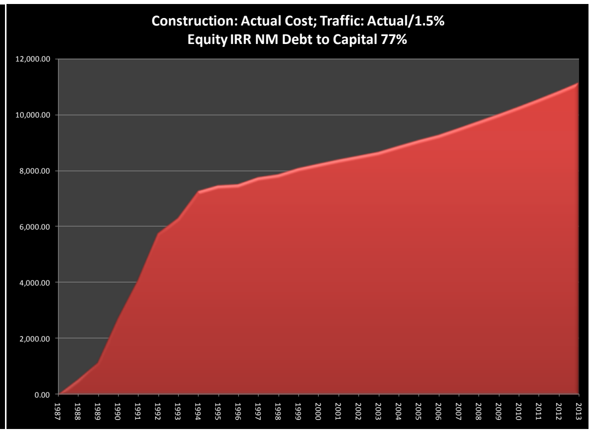
32 Muller, Robert, Separating Winners from Losers, Municipal Credit Monitor, May 10, 2002.

33 Find Reference to JP Morgan study




The traffic studies were reasonable with respect to the total amount of traffic that would cross the channel (mainly English traveling to France.) However the studies completely missed the market share that would be gained by the tunnel and lost by the Ferries. In addition, the traffic studies were wrong with respect to the growth in revenues. The number of passengers crossing the channel was expected to jump to 125 million in 2003 from 76.5 million in the 1990's. The traffic study consultants interviewed ferry companies and asked complex questions that they did not understand. Most importantly, the consultants did not recognize the potential for the bloody price war that occurred after the tunnel was built. The studies projected tolls per car of £64.5 in 1990. Actual realized tolls were only £34.4 in 1996. Given the surplus capacity that arose with completion of the tunnel (that included low cost airlines) prices moving down to short-run marginal cost should have been an expected result. The effects of the lower than expected revenues are shown in the two graphs below. The graph on the left shows the financial results for the project had the actual revenues been realized (with 1.5% growth after 2008), and the original construction budget been achieved, the project would have been eventually been able to pay off its debt and earn a small return on equity. However, in combination with the higher debt that was issued because of the construction cost over-runs, the debt could not be repaid, no matter how many attempts were made to extend the maturity of the debt or change other terms.



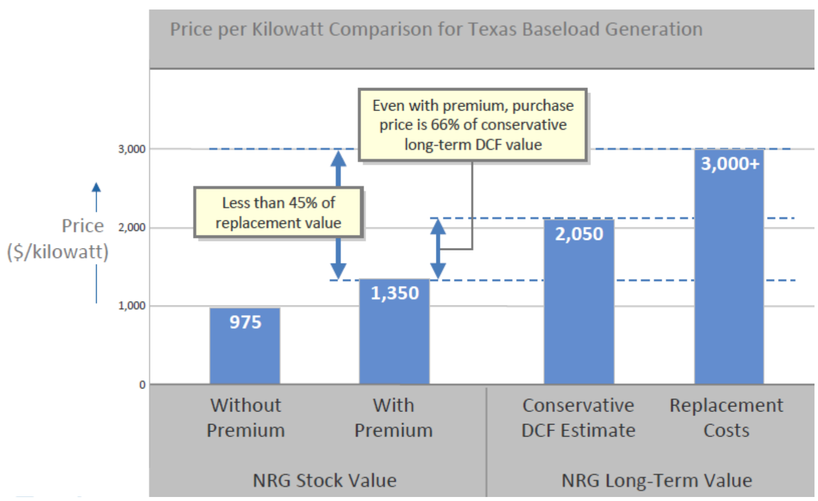
The notion of checking complex and often un-transparent valuation analyses with simple models does not mean that the thought process which goes into a simplified explanation is easy. Indeed, verification of valuations with back of the envelop analysis probably requires much more creativity and thinking about the valuation than entering multitudes of inputs into a sophisticated software model. This verification process which can involve anything from driving around inspecting the number of new homes around American suburbs to tabulating summary statistics from complex analysis is just as important as the multi-hundred page consultant report.

When analyzing a project such as Eurotunnel in which many other banks have already agreed to accept the risk, it is not easy for a junior credit analyst to question the complicated analyses that underlie the project such as a market study, a traffic analysis, a detailed synergy assessment, a set of regression equations or some other complex model. Not only have the analyses been constructed by experts who are supposedly independent, but the analyst would be questioning the judgment of many very smart financial analysts from large financial institutions. The temptation in such a case is not to take the personal risk of questioning so many others and to simply accept the complex analysis because there seems to be no other alternative. However, at minimum you can use the simpler data to develop break-even points and developing scenario analysis discussed in Chapter 3.

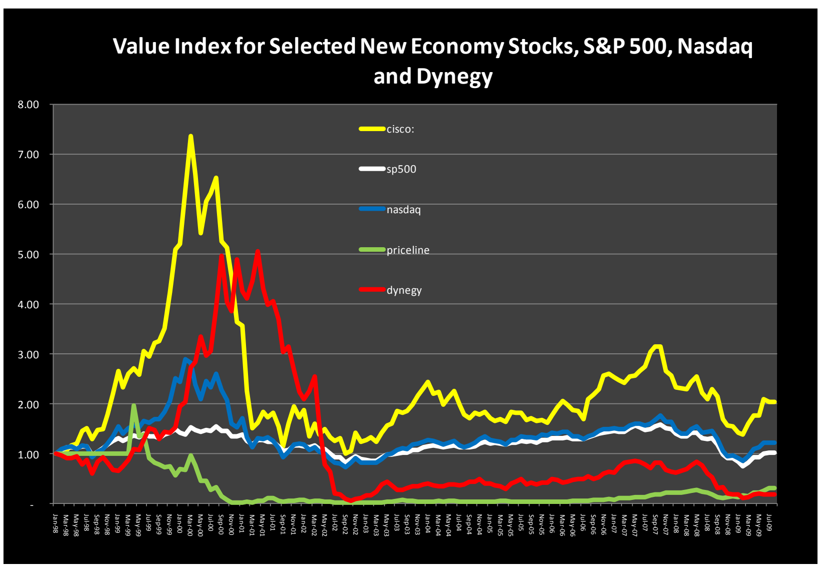
## Case 3 - Innovative Valuation Techniques and the Case of Valuing Peaking Plants using Option Pricing Models

The third case addresses valuation mistakes that arise when new and supposedly innovative valuation techniques are accepted by financial analysts without having fully worked through the fundamental logic of the approaches and without rigorously testing whether the assumptions inherent in the new models make sense. The particular situation discussed below involves the application of real options analysis which was used in valuation of electricity peaking plants constructed in the late 1990’s and early 2000’s in lieu of more traditional discounted cash flow techniques. (Peaking plants only operate during times of the year when electricity demand is very high and are a necessary component of most electricity systems because electricity cannot be stored.) Use of real options analysis and other non-traditional valuation techniques was fashionable in the mid to late 1990’s for all sorts of investments and many of the non-traditional valuation ideas continue to be a popular today. When making decisions to invest in peaking plants, the real option models were often manipulated to imply that the value of a new or existing plant was higher than its replacement cost, even though the industry was very competitive and there were minimal barriers to entry. This led sophisticated consultants and leading energy companies to argue that new investments could be very profitable even though many companies were in the business. While the analyses were elaborate, they ultimately went against some of the most fundamental ideas in valuation. The first concept that many of the analyses conflicted with is the notion that to create value, you must have some kind of competitive advantage which allows a firm to earn a rate of return higher than its cost of capital. Competitive advantage did not really exist because at the time, the market for capacity additions was very competitive and there were not many differences in technical features between the plants that were constructed by different companies. Second, application of option premiums to the value of peaking plants went against the basic idea that value comes from future cash flow along with the risk of that cash flow. The added cash flow that could be realized by the option was not observable and it was not easy to “show me the money” meaning that one could often not see how option premiums could result in actual cash flows. In particular, the option price models were misapplied because they assumed cash flows from an electricity plant result from a wandering random walk pattern rather than a process which bounces back to average levels (known as mean reversion.)

The idea of using option pricing models to value generating plants began at a similar time that deregulation of power generation was occurring in various regions of the U.S. in the mid 1990's. Deregulation resulted in many generating asset purchase and sales transactions for which values fluctuated dramatically. Most of the power plants involved in the transactions had been financed and constructed under a regulated system and, after being owned by one company for decades; they were bought and sold multiple times. A number of companies were anxious to enter the generation business including formerly regulated utility companies (who all somehow believed they had a competitive advantage in managing plants in other regions after they sold their own plants) and companies that had built independent power plants and trading companies such as Enron and Dynegy. One reason for large variations in asset prices was because some companies began to apply real options and other exotic non-traditional valuation approaches that differed from traditional discounted cash flow models. An example of the volatile plant valuations is two transactions for the purchase and sale of the same generating plants in Texas. These generating plants were first purchased by a private equity firm and then sold about two years later to NRG Energy. Even though the plants were identical, the value in the second transaction was orders of magnitude above the price in the first transaction. In some cases, the sale prices for aging and relatively inefficient plants were above the estimated cost of efficient new combined cycle plants. At the time, new combined cycle plants were estimated to cost around $400/kW to $650/kW and their efficiency had improved dramatically over the past decade. In one case discussed in Chapter 2, FPL of Florida paid more than $700/kW – well more than replacement cost -- for relatively old steam fired oil and gas plants in New England. Debates about the appropriate method to use in valuation did not end after many companies went bankrupt by over-paying for generating plants. The chart below illustrates valuations from a proposed 2009 transaction where a wide range in values resulted from application of different valuation techniques. The first two bars on the chart show that the implied valuation of generating capacity in stock prices is much less than other valuation techniques, while the last two bars show that the valuation using discounted cash flow differs from replacement cost.



Real options models were introduced to value peaking plants in the late 1990's which was the same period when innovative valuation techniques were advocated for "new economy stocks." At the time, many people suggested that classic valuation analysis founded on discounted cash flow had become all but obsolete. Real options analysis was by no means the only non-traditional valuation technique that was applied. Other valuation approaches included attempts to measure how factors such as the number of customers, supply of shares, market sentiment, chart patterns and general market psychology affected the value of an investment. The general idea of using option models for dotcom companies could be summarized as follows. Major costs of a dotcom company were often a few employees who could be sent home if the company did not ultimately pan out. On the other hand, investors believed the company could become immensely successful if the business plan was worked. Therefore, the cash flow payoffs from owning a dotcom company resembled a call option with limited downside and large upside potential. Given the cash flow patterns, factors such as the value per customer and growth in revenues drove stock prices of so-called new economy stocks rather than basic evaluation of whether the company could really produce economic profit. Because of the upside carrot and something called a "first-mover advantage", analysts would explain valuations of dotcom companies and other new economy stocks (which we now know were irrational) in very articulate terms using sophisticated financial concepts. For example, Alan Greenspan theorized that valuations of dot com companies could be explained by a "lottery effect" where investors were (rationally) looking for the next Microsoft and willing to take bets on many companies to find the good one. These new economy stocks included some energy companies such as Dynegy, Williams and Enron as well as technology and Telecommunications firms. Illustrations of selected stock prices for new economy stocks relative to the S&P 500 are shown below for companies that managed to survive the bubble without going bankrupt.




The problem with the idea that a large potential upside can be realized while the downside is limited is that some kind of real competitive advantage and barrier to entry must be present in order to ultimately realize high returns in the upside scenario. In fact, without some kind of monopoly power, large profits promised in the upside could never be realized. The problem is that if somebody else can hire a few employees and use the same business model, realizing returns far above the cost of capital is not possible in a competitive economy. Koller et. all capture the general attitudes at the time:

> *"By the time the Internet frenzy peaked at the end of the 1990s, even staunch traditionalists like Warren Buffet pondered whether the economy had entered a new era of prosperity unbounded by traditional constraints. Some economists took to questioning long-held tenets of competitive advantage, and "new economy" analysts asked, with the utmost seriousness, why a three-year-old-money-losing Internet purveyor of pet supplies shouldn't be worth more than a billion dollars."*[34]

When many electricity plants were built in the 1999-2001 period, the idea of using option price models to justifying high valuations was also used in the electricity generation industry, particularly with respect to peaking plants. The general notion was that a plant operates like an option because every single hour of the year that the plant operates, it has the option to switch off and not produce. (Chapter 5) The option not to dispatch a peaking plant meant that the downside case cash flow was limited, while more volatility in prices allowed the investment to take advantage of high prices. Intelligent and fast talking analysts taking a tour of an electricity power plant would refer to the facility as a "cloud of options" rather than a machine which uses natural gas to produce electricity. This idea that the right to dispatch could be a valuable option was explained as follows from two articles published in 1999:

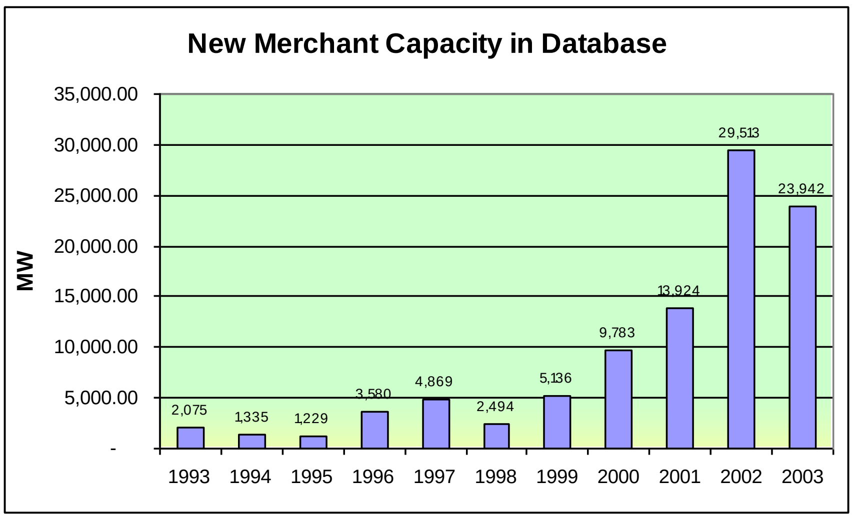
> *Commodity traders have known for some time that practical examples of real options are available every day in commodity production and distribution. It is the implicit real optionality of production assets that makes the electricity markets unique. Many types of generation assets can be economically shut down (and later restarted) in a matter of hours or days in response to market signals. Because of their high degree of operational flexibility, an electricity generation asset probably is the most practical and realistic example of a real option."*[35]

> *A generating facility is a "spread position" between the cost of fuel and the price of power, both of which are uncertain. What type of spread it is depends upon the operating characteristics of the plant. If the plant can be economically taken down and brought up in response to input and output price changes, it is equivalent to an option on the spread between the fuel cost and the power price, with a strike price equal to the cost of turning the plant on or turning it off."*

The use of real option models to value generating plants was boosted by extremely volatile prices that occurred in the summer of 1998 in the middle section of the U.S. Because of a combination of hot temperatures, nuclear plant outages, transmission limitations, and other factors, electricity prices increased from their normal levels of between \$20/MWH and \$40/MWH to \$7,000/MHW in a single hour in that summer. The extremely high prices which had never been experienced before only lasted for a few days (and the \$7,000/MWH price only lasted for an hour or two.) Despite the relatively short duration of the price spikes, they prompted many in the industry to make investments that could profit from similar spikes in the future. If prices of \$7,000/MWH could be realized only for a couple of days, the revenues realized from these two days of high price could pay off the entire capital cost of a peaking plant that at the time cost about \$400/kW. Traditional discounted cash flow models which used the expected value of data for hourly demand and the cost characteristics of generating plants in a region did not predict price spikes that could fluctuate anywhere near \$7,000/MWH. Since peaking plants would capture the value of these price spikes without a high level of investment (limiting the downside), an alternative valuation approach analogous to the dotcom company methods seemed reasonable.

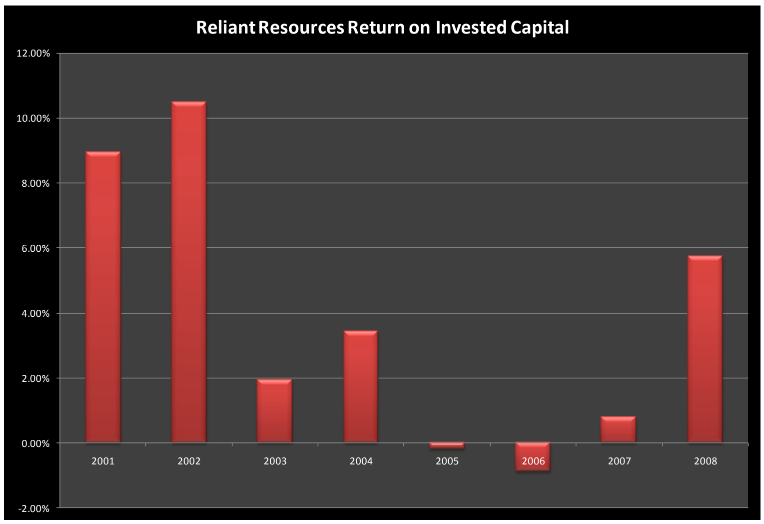
[34] Koller et. All.
[35] Derivatives Week, " ".

To compensate for problems that arise when one neglects the potential volatile distribution of prices, new peaking plants were often valued using option pricing techniques in the late 1990's. Energy companies and consultants would frequently follow a two step process when including the option value in analyses. The initial step was to compute value using traditional discounted cash flow models which measured the expected cash flows using most likely demand and supply assumptions in the market. The second step was an option increment to capture the value associated with potential price spikes and high volatility. The discounted cash flow component typically involved a supply and demand model that projected items such as electricity prices during peak periods as well as the expected utilization of the plant. This discounted cash flow part of the process was believed to undervalue the plants because it did not consider the option value from the right not to dispatch when prices are low and the opportunity to realize profits from prices which are very volatile. To account for the added option value, option price models using the Black-Scholes formula were added on top of the discounted cash flow value in the second part of the process. (Chapter 5) As mentioned above, the two step process often implied that the value that could be realized by from a new plant of plant was more than the cost of a new plant. Given that value could be realized from simply buying a peaking plant and installing it somewhere on a transmission network, in many markets such as the Midwest of the U.S. (where the 1998 price spikes occurred) a number of peaking plants were constructed. The growth in merchant plants, many of which were peaking plants is illustrated on the graph below.




Technical details of applying real options to valuation of a peaking plant involved defining a peaking electricity plant as a series of call options. For each hour, when the price of electricity is above the variable cost, the plant should operate. (Chapter 5) On the other hand, for each hour when the price is below the variable cost, the plant can exercise its option not to run. The operating cost of a plant related to purchasing natural gas can also be defined as a series of call options. For each hour the plant operates, it is exercising an option to buy natural gas. If the price of natural gas (adjusted for production of electricity) is below the price of electricity, then the option is exercised. The cash produced from the peaking plant could therefore be replicated by buying a whole lot of call options on electricity for each hour of the plants operation (the options would realize the upside) and also selling a whole lot of call options on the price of natural gas (these options would make the option holder pay for natural gas when the plant operates.) If cash flows from the plant could be replicated through buying and selling options, then the value of the plant should be the same as the value of the options. The idea certainly sounded quite sophisticated and there is nothing wrong with the theory. The problem was finding the value of options over the entire lifetime of the plant and also entering reasonable assumptions into the option pricing models.

With hindsight, the option pricing analysis did not do a very good job in valuing the peaking plants as the plants did not generate anyway near the value that was predicted by the models. The price spikes of 1998 turned out to be a one time event as the constrained capacity did not happen again due in large part to the construction peaking capacity itself as well as improved performance of nuclear plants and other capacity. The real options models applied by companies such as Dynegy, Mirant, Reliant and NRG did not account for the reduced price volatility that occurred with increased capacity installations. Companies that constructed many plants including Mirant, and NRG Energy declared bankruptcy. Other companies including Calpine, Reliant and Dynegy had dramatic declines in their value and were almost bankrupt. The return on invested capital for Reliant Resources illustrated on the graph below shows how returns fell dramatically after the addition of merchant capacity in 2002 and hovered around zero for a few years. The returns only increased after special regulations were put in place by the government to support the income of peaking plants (this was called the reliability pricing model.)




Real options analysis was interesting to sophisticated analysts and it seemed to resolve valuation issues that could not well be included in traditional discounted cash flow models. However, the manner in which analysis was applied led to many bad investment decisions. Looking back, some of the mistakes in applying the real option approach included:

- First, if the peaking plants were really more valuable than the cost of building a new plant because of the real options, then more plants would be built, increasing supply. As more plants are built because of their supposed value, the increased supply would bring down prices. With lower prices, the value does is reduced and the optionality ultimately does not produce value. As with other investments made competitive markets, earning returns above the cost of capital is difficult.

- Second, the options price models did not apply legitimate assumptions because the models did not correctly account for the very high mean reversion of electricity prices. (Chapter 3 and Chapter 5) Mean reversion dramatically reduces the value of options because the volatility that creates option value does not increase over time. In the case of electricity, volatility in supply and demand were already accounted for in supply and demand analysis, as all of the variation in weather and other factors that caused demand to fluctuate within a year were already accounted for as were potential outages in generating plants.

- Third, the options models did not quantify the reduction in price volatility that occurs when industry capacity increases. As mentioned above, the peaking plants depended on extreme price spikes which in turn occurred from uncertain weather conditions combined with capacity constraints. When capacity additions increased, the nature of supply and demand changed which implied that the volatility dramatically declined as well as prices. (Chapter 6)

- Fourth, the theoretical concepts involving arbitrage that were originally used to develop option valuation models conflicted with the idea that money over and above the investment cost could be made through investing in peaking plants. Option models were created by assuming that arbitrage strategies could be employed which means that if two alternate strategy produce the same cash flow, their value should be the same. Given that many companies could build plants to realize and create value from the option to dispatch, the value of the option could not be more than the value of the plant itself.

- Fifth, if discounted cash flow models are created from hour by hour price analysis which include all of the variability in weather and plant performance over the year. If both volatility and 100% mean reversion were included in the price projections, the expected value of cash flow does not change because of an option. There are some hours with higher cash flow and some with lower cash flow, but the option to not dispatch does not have a major effect on value. (Chapter 5)

The case of building peaking plants around the turn of the century demonstrates that while it is easy to become infatuated by non-traditional valuation techniques, realistic implementation of innovative models is more difficult to implement. When valuations deviate from the underlying present value of earnings and cash flow, financial experts tend to come up with explanations of why the current valuation is really correct and why old fashion valuation models do not work, rather than simply stating that asset prices are different than underlying value. They propound the idea that the world is really different this time and historic valuation techniques no longer apply. People who question the new techniques are scoffed at as being old fashioned and simply not having the brain power to understand innovative financial techniques. As we now know from the dotcom, merchant peaking plants and other experiences, most of the excessive valuations that were derived from non-traditional valuation techniques without paying attention to competitive advantage and cash flow were not sustainable. The danger is effectively explained by Kohler et. all:

> *"Those who questioned the new economics were handed as people who simply "didn't get it." The Internet bubble shows what happens when managers, investors, and bankers ignore the fundamental principles of economics and the underlying history of value creation…The Internet bubble years were full of intellectual shortcuts to justify absurd share prices for technology companies. The history of innovation has shown how difficult it is to earn monopolized sized rents except in very limited circumstances."*

The general discussion of real option price models does not mean that this type of analysis has no place in valuation. Option price models have become an important tool for measuring the value of many financial and real assets and the ability to quantify the value of an option contract is clearly an important innovation in finance. One of the reasons that option pricing models are so attractive is because they are built from arbitrage pricing theory and such they do not require estimation of Beta, WACC or other risk parameters that are virtually impossible to measure. Since the time Black and Scholes developed their model to value the right but not the obligation to buy or sell an asset in 1975 it has been used in more and more applications. (Chapter 5) Unlike the standard DCF models that assume cash flow distributions are symmetrical, in option price models the probability of returns below the base case cash flow forecasts are not the same as the potential for upside returns. For example, option pricing models can value situations where cash flow distributions are skewed such as cash flow realized by lenders and they have been applied to value non-financial investments such as research and development. The problem is that option price models can also be used in confusing ways to justify high valuations.

The errors in valuing peaking companies demonstrate the importance of checking the reasonableness of rate of return assumptions in financial projections. To illustrate the importance of verifying assumptions, say you are given the task to evaluate the value of a newly constructed five star hotel and there are quite a few similar five star hotels in process of construction in the area because the region has become a popular tourist destination. It is likely that your valuation process for the hotel involve examination of occupancy rates from other hotels, estimation of daily room tariffs supported by the market conditions and construction of many other assumptions regarding additional items such as food and beverage and operating costs. If, after detailed studies are made for all of these items, the analysis suggests that the overall return – the project IRR – is 45%, far above the cost of capital, one must ask what competitive advantage exists for this hotel and why wouldn't other hotels come into the market thereby brining the room tariff down. Here, the simple check is to compute the rate of return on investment implied in the valuation analysis and to question models that have returns far above the cost of capital.

When an industry is relatively competitive meaning companies can easily enter and exit, the earned return on incremental investments should not be much higher than the minimum return required by investors. If the return assumption implicit in a valuation multiple and/or the return assumption in a financial projection is substantially above the level a competitive (or the WACC if possible to calculate), then some operating assumption is probably wrong. An example of this is the equity IRR projected in the figure below computed in a similar time frame as the telecom boom, where developers of a merchant electric plant assumed they could achieve a return of almost 24% while their cost of capital was 12%. To illustrate the effect of this assumption, by earning a 24% return over the long life of a plant, an investment of $100 would grow to over $1,000 in twelve years and $21,000 by the end of the life of the plant. By comparison an investment earning the 12% cost of capital would only produce $1,700 over the 25 year life. The obvious question is if the plant could really earn 24%, why don't other developers rush into the market with the same idea. The answer is that they did and the market prices crashed because of oversupply, just like the case of the telecom crash.

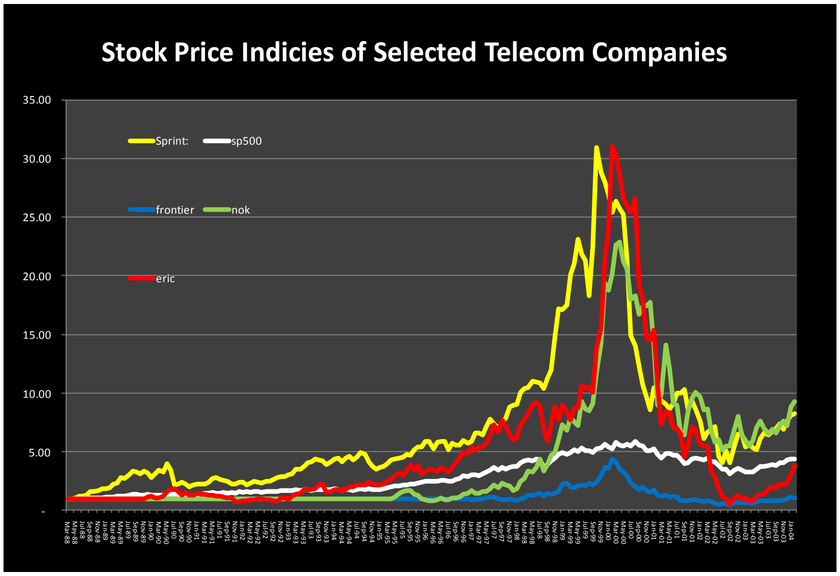
*Project Economics*

| | |
|---|---|
| Partnership Return on Equity: | 23.58% |
| Partnership NPV @ 12% (000's of $101): | $83,036 |
| | |
| Minimum Debt Coverage Ratio: | 1.60 |
| Maximum Debt Coverage Ratio: | 4.65 |
| Average Debt Coverage Ratio: | 2.98 |

## Case 4 – Obsolesce, Cost Structure and Growth without Return, the Great Telecom Meltdown and Iridium

The fourth valuation case uses dramatic valuation mistakes in valuing telecom companies in the late 1990's and early 2000's that, with hindsight, ignored the fundamental sources of valuation – earning a return above the cost of capital and then growing the business. The telecom companies that were overvalued included firms that constructed fiber optic cable, marketed long-distance service, built satellites, and attempted to compete to offer local telephone service in the U.S. (Companies that provided local service and remained monopolistic did not experience the same kind of problems.) With hindsight, the very high telecom valuations resulted from making comical assumptions with respect to both growth revenues and the ability to earn a reasonable return on investment in the long-run. Values crashed after it became apparent that vigorous competition in some parts of the business along with over-supply caused prices, returns and growth prospects all to collapse. Overcapacity resulted from massive construction of telecommunications equipment that was intended to meet extremely high projected growth rates which did not come close to materializing. A dramatic case used to demonstrate these valuation mistakes is a company named Iridium that launched 66 satellites into space to provide service across the globe and be a "first mover" in the industry. This company was created by Motorola and involved a $5 billion investment of which $3 billion was financed by debt. Iridium did not come anywhere near its targeted number of subscribers when it ran a major advertising campaign when operations began and it declared bankruptcy a year later, after which the assets were sold for only $25 million.

In the mid 1990's, many telecom companies built fiber optic cable and other equipment to serve the backbone of the internet which was growing at an extremely fast pace. The growth in the telecom was eagerly financed by both equity and debt investors who bid-up the value of telecom companies to very high levels, as anything associated with the internet was considered desirable and investors were looking for companies that would have a first mover advantage that presumably could result in a sustained competitive advantage. In a similar manner as the case with sub-prime loans, when easy financing was available, more investment occurred (once again disproving the Modigliani and Miller thesis which suggests investment decisions should be independent of financing.) It is certainly true that the growth rate in capital expenditures and to a less extent in revenues for many companies was fairly high in the mid 1990's because of growth in the internet and new telecommunication technologies. However there was no real prospect for the companies to earn anywhere near the return on capital invested required for the valuations as competition was very intense in many segments of the business and much of the industry was turning into a commodity business where prices are the driver of volumes. Eventually, investors realized that prospective return on capital would suffer because of competitiveness as well as the over-supply of capacity. With hindsight, initial assumptions behind the high valuations which implied that high returns could have been earned were never logical as there were few barriers to entry because it was easy for firms to enter the industry and finance massive capital expenditures. Values crashed as investors in debt and equity realized that genuine competitive advantage of any company that could lead to earning a return above the cost of capital did not exist meaning that the high price to earnings multiples which drove many valuations were not justified. The dramatic overvaluation and subsequent crash of the stock prices of selected telecommunications companies is illustrated on the graph below for selected companies.




We now know that many assumptions made by the most respected banks and investment banks on Wall Street were absurdly unrealistic for the industry. Some of these assumptions included:

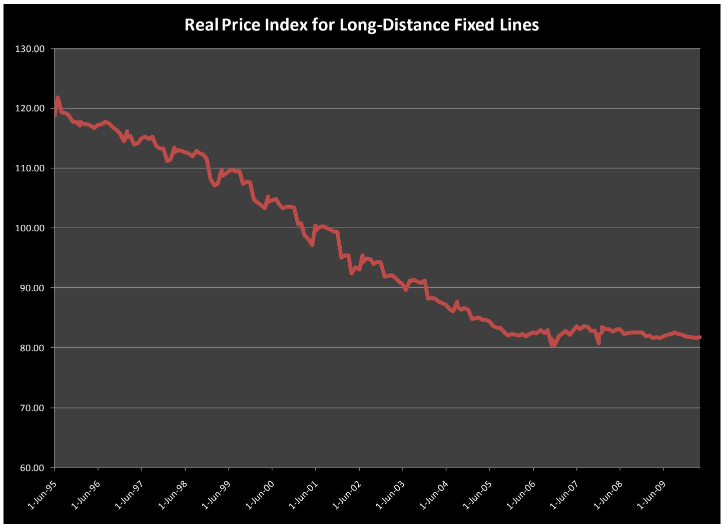
- Very high assumed rates of growth for telecommunication equipment that was required to support growth in the internet that was not logical. As recounted below, prominent industry leaders asserted that the need for telecommunication equipment was growing at an incredible rate of 10 times per year. If even a much more modest rate of growth of 30% was experienced and telecom represented 2% of the overall economy, this growth rate would leave nothing else in the economy in a matter of six years. (Appendix 2 of Chapter 2 discusses growth assumptions in more detail).

- Acceptance of valuation multiples -- P/E and EV/EBITDA ratios – that could not be justified unless both the earned return was far above the cost of capital and the growth rate was very high. The multiples were important because as equity analysts evaluating telecom companies could not justify the values of companies using discounted cash flow analysis, the valuations concentrated on comparative price to earnings (P/E) and EV/EBITDA multiples. For example the P/E ratio for Motorola, the major sponsor of Iridium, was ____ in ____ and the P/E ratio for in the MCI/Worldcom merger was ____. Using a model to derive the P/E ratio, one can derive the implicit assumptions on returns and growth that is required to justify different ratios (Appendix 1, Chapter 2.) For example, a P/E ratio of ____ could be justified if return above the cost of capital would continue to be about ___% for ____ years along with a rate of growth of ___% over the short-term. These assumptions of returns above the cost of capital were inconsistent with the fact that despite a lot of advertising and discussion of how competition would produce innovation, long distance service had become a commodity with little potential for product differentiation.[36]

- In a commodity business, the cost structure of an investment drives its profitability as products cannot be differentiated on the basis of prices. This simple principle was ignored by investment analysts who did not account for technology changes and the notion that marginal cost falls in a fixed cost industry as volumes increase.

[36] Kamala Gollakota and Vipin Gupta, "Worldcom Inc.: What Went Wrong?", 2005, Ivey Management Services

- Unrealistic beliefs that prices could be maintained in the face of massive surplus capacity. Between 1996 and 1999, almost one hundred and fifty marketing companies that buy space on networks and then sell telephone service to retail consumers entered the market. The existence of these marketing companies who operated on very thin profit margins limited the ability of larger companies that owned cable to increase prices. Competition was intensely price-based, and prices per minute fell dramatically as illustrated on the graph below.[37]

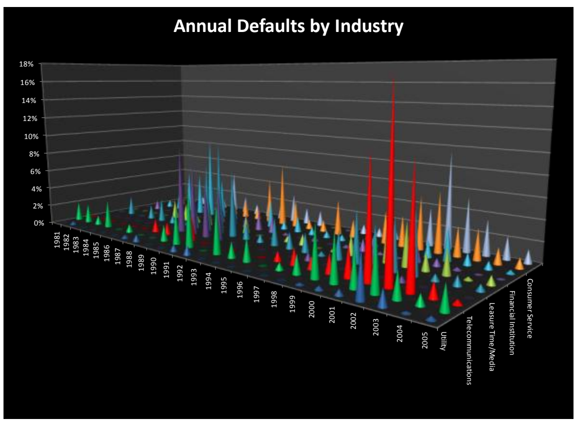


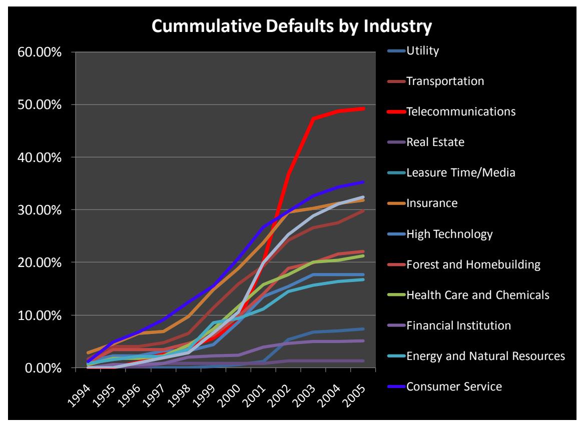

- In some cases there was an implicit assumption that prices were relatively inelastic and that consumers would be willing to pay very high prices for services that were differentiated in minor ways from each other. Telecommunication service was in reality a commodity service where competitive advantage came from either government regulation or a low cost structure.

- Debt financing was not derived from realistic downside scenarios. As will be demonstrated by the Iridium case below, loans were made on the basis of business plans with no history and depended upon implausible assumptions with respect to both price and quantity sold. Given that the debt capacity of a project depends on being re-paid in a downside case scenario, it is now clear that the downside case assumptions were not at all prudent and that the probability of default on the loans was dramatically underestimated.

[37] *"Telecom's Wake Up Call," Business Week, September 25, 2000.*

The crash in valuation of telecommunications companies demonstrates what happens when managers, consultants, investors, and bankers ignore the basic principles of how value is created and instead believe each other's stories. As in other cases, investors followed a flock instead of making independent analyses. When the market collapsed in 2001 and 2002, the fall in market values of both debt and equity was dramatic. According to one estimate, the decline in market value of debt and equity for companies in the telecom industry exceeded two trillion U.S. dollars.[38] In 2001, seventy seven companies declared bankruptcy including Worldcom, which up until the fall of AA rated Lehman Brothers was the largest bankruptcy in U.S. history. Other noteworthy telecom bankruptcies included Global Crossing, the fourth largest bankruptcy in U.S. history along with Williams Telecom and Network Plus.[39] The two graphs below illustrate the volume of defaults in the telecom industry as compared to some other industries; the cumulative default rate from 1994 to 2005 was more than 50% and far exceeded the defaults of other industries even at a time when overall defaults reached historic highs.[40]




One of the bases for the high valuations for telecom firms was the assumption that the demand would dramatically increase and allow prices for products supplied by telecom companies such as bandwidth to remain relatively high. Valuations implicit the P/E ratios and the EV/EBITDA multiples before the crash made the explicit or implicit unrealistic assumption that the telecom sector would expand perpetually by 15 to 30% per annum. The kind of thinking behind the demand forecasts during the boom period is recounted as follows in "The Great Telecom Meltdown:"

> *During the boom many people believed that Internet traffic was doubling roughly every 100 days. This fantasy was based on statements made by WorldCom in the 1997 time frame….It led to financiers to put up trillions of dollars in capital. After all, demand would soon catch up with whatever supply that could be built.*

The specific reference to this growth rate was a statement of the chief financial officer of Worldcom, John Sidgemore, who stated[41]:

> *We're seeing growth at an unprecedented level. Our backbone doubles every 3.7 months, which means that it's growing by a factor of 10 every year. So three*

[38] Goldstein, Fred, "The Great Telecom Meltdown, Artech House, 2005, Norwood MA.
[39] Freeman, Richard, "Meltdown of the Telecoms Continues, and Threatens World Financial System", April 12, 2002, Executive Intelligence Review.
[40] Standard and Poors.
[41] Crowe, Thomas, "The Telecom Meltdown…Looking For The Underlying Reasons"

> *years from now, we expect our network to be 1,000 times the size it is today. . . . The big challenge is to deploy infrastructure fast enough to accommodate such a growth rate. We're in a supply-constrained economy for the first time in the telecom industry.*

Mistakes in valuing telecom companies were a cousin of valuation errors in the dotcom bubble where companies that were associated with the internet achieved valuations that are nonsensical with hindsight. Because of the internet traffic that began to increase at a high rate in the 1990's, the telecommunications industry began to carry more traffic related to data than to voice calls around 1996.[42] In the U.S., telecommunications networks built by AT&T, Sprint and MCI were running low on capacity and before 1995, prices for bandwidth to carry voice and data increased. In the late 1990's when access to capital was very easy -- driven by high valuations -- massive capacity expansion of fiber optic cable between cities occurred in the U.S. and elsewhere around the world (a company named Global Crossing placed large amounts of fiber underneath the Ocean.) During the boom period, companies installed fiber optic cable along railway lines, gas pipelines, roads and in other places. It seemed that to achieve a high valuation, companies could simply announce that they were in the process of building a national or super-regional fiber-optic network. Sometimes four to six companies built fiber-optic cable networks between or within the same major cities, which turned out to be orders of magnitude beyond prospective levels of voice or data transmission.

Unlike other industries, the amount of capacity and demand for bandwidth is not published and is not readily available (it is not in the economic interests of companies in the business to show the extent of the overcapacity.) However various sources have cited the immense amount of overcapacity in the industry. One study reported that 39 million miles of cable were laid underneath railroad beds, natural gas lines, corn fields, and roads—enough to encircle the Earth more than 1,500 times.[43] Another analyst reported that over the four years between 1998 and 2001, the amount of fiber in the ground increased five-fold. The five-fold increase, which is a lot, does not account for the technological advances in the capacity of fiber increased the transmission capacity of fiber by 100 times relative to the copper wire that had been previously used in the industry. This means that the true transmission capacity increased by a whopping factor of 500, nowhere close to the increase in demand driven by the internet.[44] Yet another source suggested that there was an overbuilding of fiber-optic cable systems by a factor of at least ten times, meaning that most of the fiber cable that was laid in the ground is not even used. (Fiber optic cable requires computerized technology to make it work; until this is installed, the fiber optic is known as dark cable. As of 2006, less than 5% of the cable was "lit"; the rest remains dark, and most is not likely to be "lit," implying massive excess capacity.)

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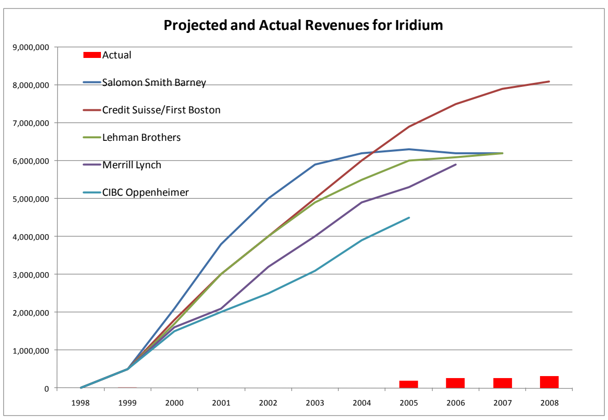
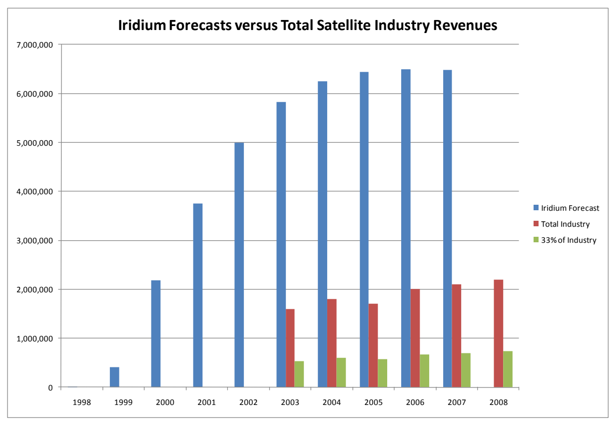
[42] Goldstein, Fred, "The Great Telecom Meltdown, Artech House, 2005, Norwood MA.
[43] Crowe, Thomas, "The Telecom Meltdown…Looking For The Underlying Reasons"
[44] "Too Many Debts, Too Few Calls," The Economist, July 18, 2002.

Examining the specific case of the Iridium satellite venture illustrates the type of errors made by financial analysts at the time. This company's $5 billion investment was predicated on the assumption that more than six million people would pay fees that exceeded $330 per hour to use the service. To arrive at the revenue assumptions made by prominent investment banks -- illustrated on the left hand side graph below -- one would have to assume that 30% of international business travelers would carry around an extra brief case with a large bulky phone that was very difficult to use and unreliable inside of an office building or a hotel. Prices charged by Iridium were to be lower than the current international rates; but there was no evidence that business travelers were already paying the high existing landline rates and this market could be diverted. As it turns out, virtually no business travelers used the Iridium phones and the revenue projections were nowhere close to amounts projected by Iridium's consultants and investment banks. The graph on the right displays the forecast made by Salomon Brothers, Iridium's financial advisor, to the total actual revenues received by all satellite companies and 33% of the total industry revenues (representing the expected Iridium market share.) The left hand side graph demonstrates the manner in which a number of investment banks acted like lemmings in making similar analyses and ignoring the most basic economic principles of price elasticity of demand. The graph on the right illustrates that problems in estimating revenues were not related to specific marketing problems at Iridium involving the availability of phones and the difficulty in using phones, but rather the subscribers for the entire industry were overestimated.




Perhaps the most intriguing question in the Iridium case is not the equity investment, but how could banks and other lenders provide more than $2.2 billion of debt to the venture (the balance between the $2.2 billion and the $3 billion of debt discussed above is $800 million of debt guaranteed by Motorola and $240 million of subordinated debt provided by equity sponsors.) The timing and amount of debt capital raised by Iridium is illustrated on the sources and uses statement below. Decisions to make loans to the venture were surprising because there was no historical basis upon which a banker could verify the projections that were; there were no comparable projects that could be used to verify the project; and there were no contracts that guaranteed any revenue. Instead, according to the Iridium prospectus, estimated revenues derived from "interviewing more than 23,300 people." If lenders had simply seen the size of the phones and understood the complexities in using the phones (information that was publically available in the prospectus), they surely would have been very skeptical of the projections and demanded much more than credit spreads ranging between 2.75% and 9.5% (the interest rate on treasury bills was about 4.5% and interest rates on the bonds ranged from 10.88% to 14%).

| | Total | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Uses of Funds** | | | | | | | | | | |
| Payments Under Space System Contract | 3,380,000,000 | 98,500,000 | 98,500,000 | 197,000,000 | 197,000,000 | 802,000,000 | 836,000,000 | 577,000,000 | 574,000,000 | - |
| Payments Under Terrestial Contract | 238,000,000 | - | - | - | - | - | - | 64,000,000 | 174,000,000 | - |
| Other Construction Expenditures | 409,002,000 | 18,312,750 | 18,312,750 | 18,312,750 | 18,312,750 | 26,178,000 | 164,415,000 | 145,158,000 | - | - |
| Pre-Operating Expenses | 749,162,000 | 5,483,000 | 5,483,000 | 10,966,000 | 16,729,000 | 26,436,000 | 70,730,000 | 177,474,000 | 435,861,000 | - |
| Interest Paid | 362,552,300 | - | - | - | - | - | 18,937,500 | 113,170,000 | 230,444,800 | - |
| Total Uses of Funds | 5,138,716,300 | 122,295,750 | 122,295,750 | 226,278,750 | 232,041,750 | 854,614,000 | 1,090,082,500 | 1,076,802,000 | 1,414,305,800 | - |
| **Sources of Funds** | | | | | | | | | | |
| Equity Financing | 2,140,000,000 | 200,000,000 | 200,000,000 | 200,000,000 | 200,000,000 | 800,000,000 | 315,000,000 | - | 225,000,000 | - |
| Guaranteed Bank Facility | 745,000,000 | - | - | - | - | - | 505,000,000 | (230,000,000) | 350,000,000 | 120,000,000 |
| Senior Bank Facility (Spread of 2.5%) | 800,000,000 | - | - | - | - | - | - | 300,000,000 | 200,000,000 | 300,000,000 |
| Senior Notes - A (Yield of 13%) | 278,000,000 | | | | | | | 278,000,000 | | |
| Senior Notes - B (Yield of 14%) | 480,000,000 | | | | | | | 480,000,000 | | |
| Senior Notes - C (Yield of 11.25%) | 300,000,000 | | | | | | | 300,000,000 | | |
| Senior Notes - D (Yield of 10.88%) | 342,000,000 | | | | | | | | 342,000,000 | |
| Subordinated Notes (Yield of 14.5%) | 238,453,000 | - | - | - | - | - | 238,453,000 | - | - | - |
| Interest on Cash Balance | 1,027,260,859 | - | 2,331,128 | 4,732,189 | 4,085,792 | 3,247,113 | 1,706,107 | 808,405 | 3,405,868 | - |
| Total | 5,343,769,601 | 200,000,000 | 202,331,128 | 204,732,189 | 204,085,792 | 803,247,113 | 1,060,159,107 | 1,128,808,405 | 1,120,405,868 | 420,000,000 |
| | | | | | | | | | | |
| Percent Equity | 40% | | | | | | | | | |
| Percent Guaranteed Debt | 14% | | | | | | | | | |
| Percent Senior Debt | 41% | | | | | | | | | |
| Percent Subordinated Debt | 4% | | | | | | | | | |

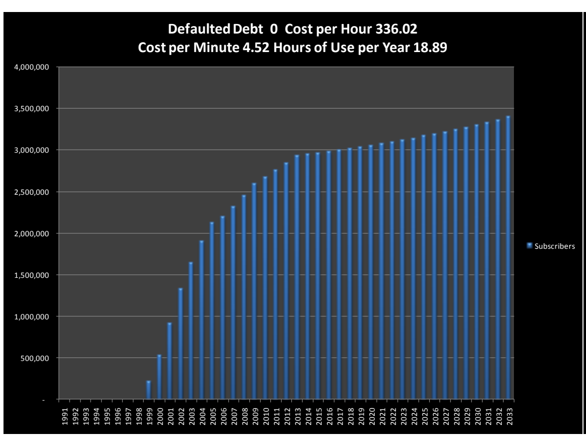
The high level of the credit spread may make one think that even if the project ultimately defaults, the high earnings from the credit spread in time period over which it did not yet default could make the high yield bond a good investment even if the bond ultimately did not pay its principal. For example, in an extreme case where the credit spread is 100%, the bondholders would have done better than the bondholders in government debt as long as the bankruptcy does not occur in the very first year. However if the loan defaults in the very first year and the recovery is zero (the loss given default is 100%) then bondholders lose everything. The required default rates to make a loan with a credit spread of 9.5% -- the highest credit spread for senior Iridium debt -- produce a profit relative to the risk free rate are shown on the table below. The first column of the table shows the rate of return realized by bondholders if the loans default in various periods; for example, if the loan defaults in the first year, the realized return is -91%. The second column shows the percent of default that could be acceptable if the loan were to realize the same expected return as a risk free bond. For example, if there was a 9% chance that the loan would default in the first year, then the negative return of 91% would be acceptable if there was only a 9% that the loan would default. As the loan is outstanding for longer periods, the acceptable default increases because of earnings received on the bond.

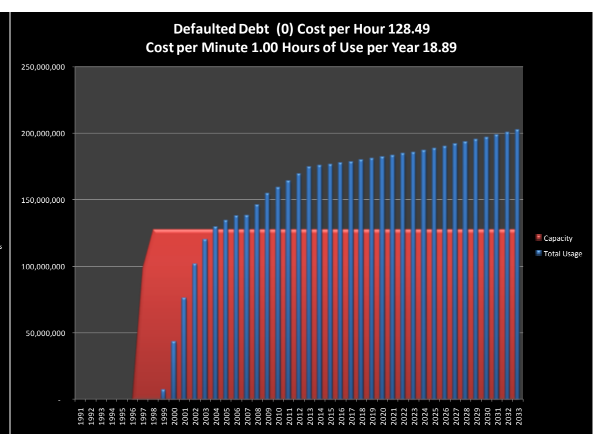
| Default Year Assuming 100% Loss Given Default | IRR Earned on Debt Assuming Default in Various Years | Acceptable Default Probability to Be Equivalnet to Risk Free Rate | Expected Value from Default | Probability of Non Default | Expected Value from Non Default which is credit spread | Total Expected Value on Bond: IRR on Debt x Pd + Credit Spread x (1-pd) |
|---|---|---|---|---|---|---|
| 1 | -91.00% | 9% | -8.40% | 91% | 9.25% | 0% |
| 2 | -65.16% | 12% | -8.10% | 88% | 9.25% | 0% |
| 3 | -44.95% | 17% | -7.67% | 83% | 9.25% | 0% |
| 4 | -31.22% | 23% | -7.14% | 77% | 9.25% | 0% |
| 5 | -21.83% | 30% | -6.50% | 70% | 9.25% | 0% |
| 6 | -15.20% | 38% | -5.75% | 62% | 9.25% | 0% |
| 7 | -10.38% | 47% | -4.89% | 53% | 9.25% | 0% |
| 8 | -6.77% | 58% | -3.91% | 42% | 9.25% | 0% |
| 9 | -4.02% | 70% | -2.80% | 30% | 9.25% | 0% |
| 10 | -1.87% | 83% | -1.56% | 17% | 9.25% | 0% |
| 11 | -0.17% | 98% | -0.16% | 2% | 9.25% | 0% |

Note: If IRR is zero, then the return earned on the bond is equivalent to a risk free bond
The Acceptable Default Rate is -credit spread/(IRR-Credit Spread)

The problem with Iridium from the standpoint of lenders is that either the technology would work from an economic perspective or it would be a flop; there was no in-between. Further, if it did not work, the failure would be quick. This is because the limited capacity of the satellites combined with the manufacturing cost of the phones meant that there was no flexibility to reduce prices. If business travelers would not adopt the satellite system, there was no “Plan B” that could be employed that would avoid a default and find enough cash flow to service the debt from other sources. Using the above table, this means that even if the company could struggle and stay in business for a couple of years, the only way the bonds could be profitable would be if with an 80% chance that chance that the business plan would really work. For the loans with a lower credit spread, the chances would have to be about 90% (the relationship between the probability of default and the credit spread is discussed in Chapter 4.) Analysis of the cost structure presented below demonstrates that the Iridium technology was not only highly exposed to obsolesce in the future, but that the technology was already obsolete at the time the loans were made. Making bets that a new technology with a high cost structure will have an 80% to 90% chance of success in a rapidly changing industry with a very high cost structure is an absurd bet for lenders.

Case studies written on Iridium typically describe the failure in terms of marketing problems. The company got the pricing completely wrong; it did not package the phones correctly – they were too large and bulky; and it did not manage the distribution channels correctly as it could not follow-up on a major advertising campaign. To test just whether alternative marketing strategies could have solved Iridium’s problems, a financial model could be used. If the company would have reduced the price in attempting to increase usage, the financial model shows that capacity constraints made this unfeasible. This means the most essential point was not really marketing, but that the underlying cost and capacity constraints made the project uncompetitive with other technologies. A break-even analysis demonstrates that if all of the rest of Iridium’s very optimistic assumptions with regard to price and usage could have been realized, the company would have still required about 3 million subscribers to repay its debt and provide lenders with their full return as shown in the left-hand side graph below. (Chapter 3) This amount of subscribers is more than the total subscribers that were actually achieved in the entire industry. Finding 3 million subscribers to lug around phones so they can pay rates of $330 per hour and not even use phones in buildings should have raised a lot of questions and put the business plan in doubt. If the price were reduced from $4.6 per minute to $1 per minute, (still a very high price compared to using cell phones for many international calls), then Iridium would have needed about 14 million subscribers to break-even as shown by the red graph on the right-hand side graph. However, with this many subscribers, the capacity of the system would be far exceeded as illustrated by the straight line on the graph. If the cost was further reduced to be to be any near realistic levels such as $.25 per minute or less, then the usage would have to far exceed the capacity. Finally, had Iridium borne the up-front cost of phones as a marketing strategy or had it spent more on making the phones smaller and sleeker, then the company’s financial condition would have been even worse.



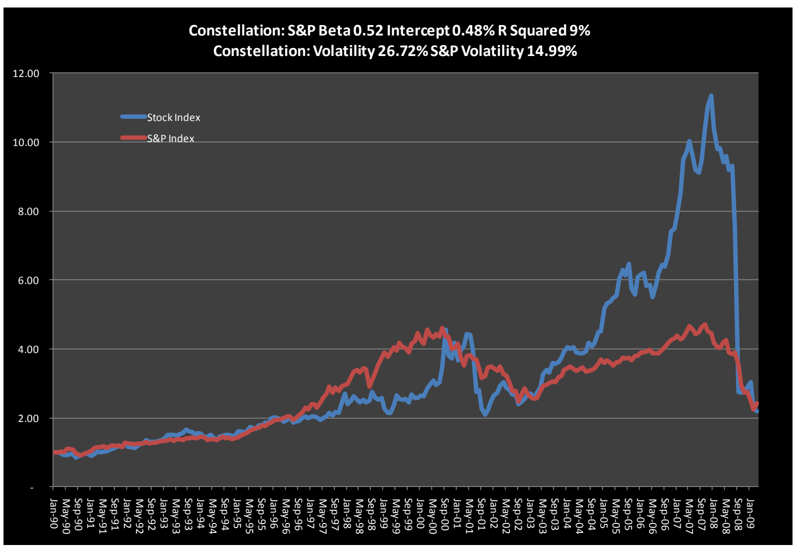
It may seem that in assessing the prospects for repaying debt that developing a financial model of Iridium would be all but useless. Attempting to carry around the bulky phones and understanding that they are very difficult to operate inside buildings should have been enough to refuse to lend any money to the project. However, collecting the data required to build a model and then understating how the model can perform break-even analysis as well as simple sensitivities does illuminate just how remarkable it was that the company obtained so much debt financing. When one computes a simple statistic involving how much the phone service costs retail consumers on an hourly basis – more than $330 per hour – one should have become very skeptical of whether 30% of business travelers would really use the service. Somebody would have to consider oneself very important to spend much time on the phone when it costs this much.

The underlying logic of Iridium was similar to the valuation process for many telecom company valuations being derived from a high growth rate in which market penetration and market share were often assumed to increase thereby justifying high valuation multiples – P/E ratios and EV/EBITDA ratios. The valuations were flawed not only because of the unrealistic demand growth assumptions but more importantly because of the implicit assumption that eventually, Iridium could earn a return above the cost of capital even though it did not have a viable cost structure and was obsolete before it was built. In the case of Iridium, the assumptions depended on realizing prices that could not be achieved in the face of competing technologies. When telecom investments obtained very high values, investors seemed to believe that merely building capacity in order to grow faster than your competitors would result in enormous value, even though there was no clear competitive distinction that would allow a company to earn a return above its cost of capital. For example, in the case of mobile-phone companies, growth in revenues and market share meant competing largely on price which in turn kept returns relatively low. For providers of fiber optic cable, even if growth could have been achieved, high returns would be extremely difficult to achieve because of the commodity nature of the business. The users of data, for the most part corporations, were paying lower prices for the data in bulk instead of paying on the more expensive per-minute basis.

## Case 5 – Not Accounting for Risk in Valuation Multiples and Modeling Cash Flow, the Case of Constellation Energy

The fifth case study addresses the importance of using appropriate information when evaluating the relation between the earned rates of return and the risk of cash flow variation as well as problems that occur when valuing an investment using multiples or discounted cash flow. The case used to demonstrate this problem is Constellation Energy, a company that experienced a dramatic decline in stock price on the day after Lehman Brothers declared bankruptcy in September 2008. Through swallowing confusing presentations by management without working through where sources of cash flow and by not correctly considering risks of the business, the company was dramatically overvalued in the boom period before the crisis. Management had attempted to manage earnings growth and stock value through entering businesses in which it had no competitive advantage and hiding trading risks it was taking on by presenting financial reports in an opaque manner which did not delineate cash flow from its different business activities. The lack of transparency apparently prevented analysts from developing effective financial models of the cash flow, assessing risk and using appropriate valuation multiples such as the P/E ratio and the EV/EBITDA ratio when valuing the company. As the true risks that the company was taking became apparent during the months of turbulent energy prices and stock prices in the autumn of 2008, its stock value plummeted dramatically.

Changes in the value of Constellation are demonstrated by comparing the years 2006 through 2008 for the company. 2006 and 2007 were good years for Constellation Energy from a financial standpoint. Its stock price rose from $57 per share at the beginning of the 2006 to $103 at December 31st of 2007. Including dividends, the growth in cash flow to investors over the two years was 78%. Times were also good for Constellation's CEO, Mao Shattuck, a former investment banker at Deutchebank as he earned compensation of $12 million. 2008 was a different story. The company's stock price fell to $13 per share in intraday trading on September 16th – the day after the Lehman Brothers collapse. By March 2009, the stock price had settled at about $18 per share. In terms of total market value, Constellation investor losses were $16.5 billion – falling from a market capitalization of $18.8 billion (share price multiplied by the number of shares) all the way down to $2.3 billion. In attempting to maintain value, Shattuck made a decision to merge with MidAmerican Energy on an expedited basis. A couple of months later he cancelled the transaction, costing shareholders more than $2 billion in fees and stock dilution, representing 45% of the total merger offer. Constellation finally entered into a transaction with EDF Development Inc. (a subsidiary of Electricite de France) but its stock price has remained low. The dramatic change of Constellation's stock price is illustrated by the graph of its stock price compared to the S&P 500 below. The question addressed in evaluating this case is what if anything was wrong with the valuation before the crisis and whether the crash in stock prices reflected the true value or whether it was just panic that had little to do with fundamental value.




Studying Constellation Energy illustrates the type general type of valuation errors that led to a fall in stock prices of 53% during the financial crisis (from August 2008 to March 2009) as well as the inappropriate application of valuation multiples and value at risk statistics in valuation and risk assessment. A few months before the crisis, Constellation presented an analysis demonstrating that its value should range from ___ to ___ as shown in the table below. After the stock collapsed, Morgan Stanley made a similar analysis suggesting the value was only ranged from ___ to ___ which is presented alongside the Constellation analysis. Both valuations could not be correct. Evaluating what was wrong with the analysis in this extreme case allows one to see general problems that occur with the way valuations are made in practice. The case involves delving into the type of analysis that was made before the financial crisis that led to unrealistic valuations in a detailed manner. This contrasts with vague statements about over-leverage, overly complex financial instruments or lack of transparency.

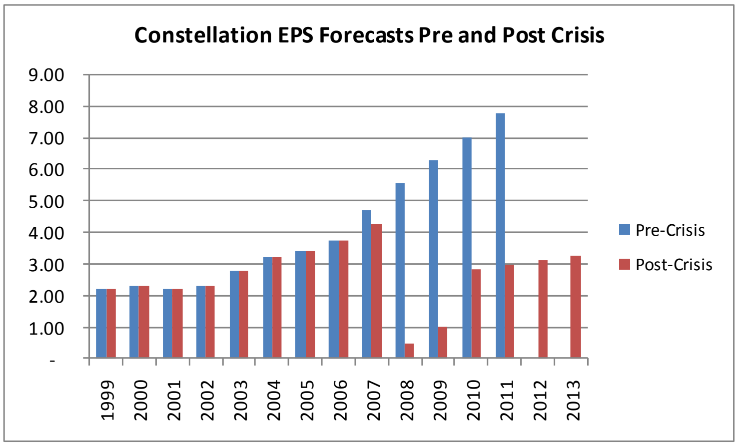
When considering the dramatic changes in valuation of Constellation, one can start with the basic concept that the underlying value of any business enterprise comes from competitive advantage and the ability to produce more benefits to owners than the investors could realize from other investments – earning a return above the cost of capital. (Chapter 4 Appendix) In order to earn returns above the cost of capital, a business must create some kind of sustainable competitive advantage. This competitive advantage may come from efficient cost structures, innovative products, superior investment timing or monopoly power. When a company suggests that it can earn extraordinary profits without doing anything special, such as speculative trading, selling credit default swaps, or buying business that are fundamentally unrelated to its historical skills, you should step back and ask the question what makes the company unique. Multiples such as the P/E ratio come from the ability of a company to earn a return above its cost of capital and grow a business. If the multiples obtain high levels without both competitive advantage and growth, the ratios may be dangerously high. For example, the P/E multiple should be quite different for trading operations than for a power plant that receives revenues from fixed power contracts.

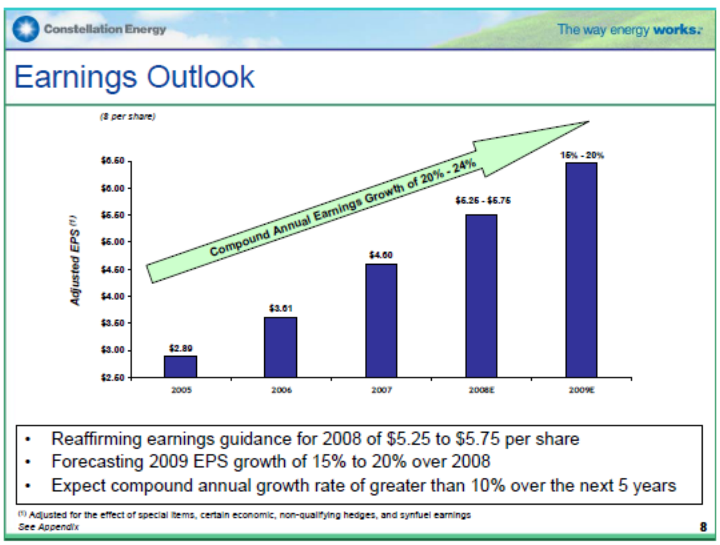
To understand the valuation of Constellation Energy, one can look at the stock prices prior to 2006 which were unremarkable compared to companies engaged in similar activities. According to Mao Shattuck, Constellation's CEO, the company has been "laser focused" on increasing its stock price. Generating earnings growth with existing businesses was difficult for the Company because Constellation purchased three nuclear plants at premium prices in New York that came along with fixed price power contracts (as with many descriptions of its business activities, Constellation used language that sounded sophisticated and did not call them contracts. Instead it used the phrase "below market hedges" implying that the company had somehow use energy trading strategies to reduce risk). In terms of return, Constellation lagged behind its peers who were earning high returns from the transition to deregulated rates as shown in the table below. Mao Shattuck's solution to the divergence in returns was to expand speculative trading and purchase companies that could produce near term earnings with increasing energy prices.

**Return on Equity Reported by Value Line**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|
| Exelon | 17.20% | 20.10% | 18.80% | 19.50% | 23.60% | 23.70% | 26.90% | 24.60% |
| PSEG | 18.60% | 18.60% | 18.60% | 18.60% | 18.60% | 18.60% | 18.60% | 18.60% |
| PPL | 20.80% | 18.10% | 20.20% | 16.10% | 16.50% | 17.30% | 18.20% | 18.20% |
| **Constellation Energy** | **9.20%** | **9.30%** | **11.10%** | **11.70%** | **12.30%** | **14.80%** | **14.70%** | **2.60%** |

The strategy seemed to work as shown by the earnings per share projections before the crisis presented on the graph below. This is shown in the graph below which demonstrates the earnings per share projections before and after the crisis. Before the crisis, Constellation's P/E ratio reached 20.1 because of the expected earnings per share increase. Earnings projections by investment analysts were in large part driven by the guidance provided by management as presented in the second graph below. The company had consistently met or exceeded the earnings projections which seemed to give analysts confidence about the future earnings, even though it was very difficult to verify exactly where the future earnings were to come from. The manner in which the earnings projections typically translate into expected prices and returns is typically multiplying the expected earnings by a future assumed P/E ratio as illustrated below. This is analogous to a discounted cash flow model where an explicit period of cash flow is modeled and then a terminal value is computed using multiples such as the P/E ratio or the EV/EBITDA ratio.




While the return on equity of Constellation Energy was lower than its peers, the company was able to increase earnings per share through growing something it ultimately named its commodities business (this was not named and segregated as a separate item in financial reports until 2008 when the stock price began to fall). By contrast, the peer companies shown in the table above were primarily in the business of selling electricity from merchant generating plants and operating regulated distribution companies. As shown in the table below (which was not published until the stock price was crashing in 2009), Constellation's earnings in 2007 and 2007 almost fifty percent of its earnings were comprised of trading related businesses named customer supply and global commodities. The company bought ships that transported coal and used the sophisticated but confusing phrase named "freight intermediation." Constellation purchased about $1 billion of oil and gas producing properties and named them "energy related assets." It explained the purchases with the puzzling logic that: "As a merchant supplier [of electricity], we are able to identify opportunities to serve customers, which provides the insight to acquire assets and deploy risk capital at the right time." Finally, Constellation often used the term that it "deploys risk capital in traded energy markets" to describe its trading business, which apparently meant speculating on energy prices. Investors ultimately found out that this meant taking speculative positions on energy prices.

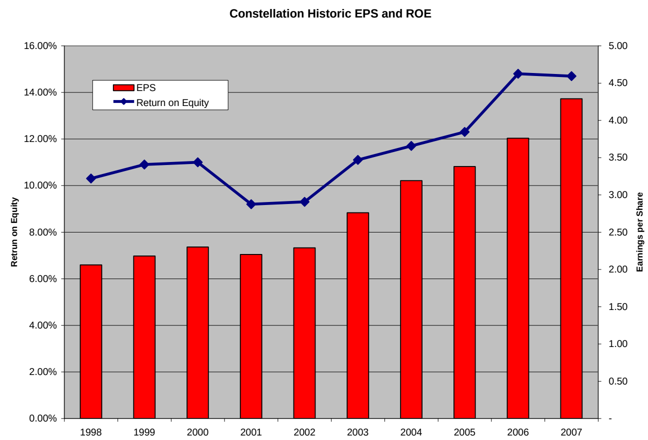
**Constellation Merchant Segments Reported in 2009 ($ millions)**

| | 2006 | 2007 | 2008 |
|---|---|---|---|
| Gross margin: | | | |
| Generation | 1,490 | 1,700 | 1,956 |
| Customer Supply | 764 | 889 | 765 |
| Global Commodities | 656 | 654 | 260 |
| Total | 2,910 | 3,243 | 2,981 |
| Generation Percent | 51% | 52% | 66% |

The strategy of increasing earnings through expanding trading and buying energy assets did increase earnings as shown on the graph below, but it also caused a couple of problems for Constellation. The first problem was that trading profits were not generally valued highly by the stock market meaning that the increase in earnings would not necessarily translate into a higher stock price. It is natural for investors to value trading profits much less than profits from other activities such as selling power because if investors want to take speculative positions in energy markets, they can do so without a corporation making trades on their behalf. For example, if an investor would like to bet on the price of electricity going up, he could buy a forward contract for a fixed price and then if the actual price exceeds the contract price, he would realize a profit. There is no reason for Constellation to be involved in this transaction and if this is all that the company is doing, investors would surely want to know. The second problem was that the trading profits had different risk characteristics and were more difficult to evaluate than cash produced by selling electricity from a plant. When discounting earnings from trading activities, the discount rate applied to these cash flows would be much higher than the discount rate applied to other activities. The problems faced by Constellation are illustrated by the following statement by Mao Schattuck suggesting that investors do not attribute enough value to the company's brilliant skills in trading and marketing[45]:

> *…the [commodities and marketing] businesses that had grown so fast and that had created so much earnings power had reached the point where they constituted close to 40% of the earnings power of the company. It became apparent that investors were going to have a hard time valuing a company like ours that had a utility, had merchant generation and had a commodities business that was expanding. We … had to address the issue of … whether earnings coming from the commodities group would … add no value to the shareholders worth.*

[45] Tom Brooks, Deutsche Bank Conference, May 2008




Constellation would surely not admit it, but management essentially attempted to solve the above two problems by obfuscating reporting of its historic financial results and presenting earnings projection guidance in a confusing and opaque manner. Indeed, the Constellation case can be used to define what being non-transparent really means and how incentives to be opaque with information are directly related to engaging in business activities that do not produce true value. Constellation's financial strategy was demonstrated by not presenting marketing or trading profits on a segregated basis in its financial reports; asserting that trading activities were not speculative, but instead were simply being used to hedge other activities; showing how smart the management is by using terms in investor presentations that were so confusing as to require a translator; presenting confusing risk exposure statistics; and making aggressive earnings forecasts without explaining value drivers. Because cash flows for different segments of the company were not presented in a transparent manner, analysts who attempted to value the company could not separate cash flows earned from the speculative trading activities from cash flows associated with the generating plants and the analysts could not apply different risk premiums and multiples to the different businesses.

The first aspect of transparency involves presentation of Constellation's financial statements. The problem was not that assets were hidden in special purpose vehicles, but that cash flows from different businesses were mixed together. Before 2008, investors had no way to differentiate between the safe and stable profits made from selling power from one of its nuclear plants under fixed price purchased power contracts from the profits made by speculating on the direction of energy prices. The volatility of cash flows, cash flow drivers and trends in future cash flow were different for each business segment and the historic data was useless in making valuations. Constellation was hoping that the aggregate cash flows would be valued at the price to earnings and other multiples of peer companies that had safer businesses. As a contrast to Constellation's reporting, another company named NRG Energy reports the amount of projected revenues under contract, the revenues earned from trading profits and the revenues earned from spot sales in each region that it operates. The contrast with Constellation is stark. Not surprisingly, investors had been complaining about Constellation's transparency in reporting its results for years as illustrated by the following talk given by the company's chief financial officer:

> *We continue to hear from you regarding the transparency of our business and our overall disclosure…[In] improving transparency … we will be working towards discrete reporting on each business unit to provide more detailed information on segments currently reported. As you are aware, in 2008, we refined our reporting to show gross margin by activity…*

Lack of transparency for Constellation was not limited to its financial presentation. The second aspect of its opaque presentation was the manner in which Constellation explained its businesses to investors. Language used by Constellation is a good example of the way finance professionals attempt to create confusion though showing how smart they are. In earnings conference calls and other presentations, Constellation would use phrases such as “asymmetric collateral requirements”, “deployment of risk capital”, “leveraging business platforms”, “as priced margins”, “transitional liquidity”, “right-sizing of strategic footprints” and many others. The general idea of the presentations seemed to be that investors should trust the superior qualities of the company and not worry about risks in the business ad illustrated by the following statement made by Mao Schattuck: “the realignment of all our merchant businesses allows us to leverage our world class capabilities in risk management and portfolio management across our industry-leading platform.” When listening to Mao Schattuk and other Constellation managers, if you are impressed by confusing financial terms, you would think they really were very smart. Listening to Constellation management before the collapse, it was easy to feel quite inferior to their superior intellect.

A third component of non-transparency was the way in which Constellation belittled its exposure to potential losses from its trading activities by emphasizing that most of its trading was for hedging activities related to its merchant plants; for hedging for customers; and, hedging its coal business. The chairman of Constellation never directly admitted that the company had been engaging in speculation until he discussed the transaction with EDF in December 2008, when he discussed “taking positions.” Implications that the company was not significantly betting on energy price movements were contrary to other statements made by Constellation and the volatility in its financial results. For example, management stated that it was bullish on energy prices in its second quarter 2008 conference call. One of the company executives reported: “…we entered the second quarter bullish on energy commodities …” If Constellation was simply hedging its positions, it would be neither “bullish” nor “bearish” on energy prices. In fact, Constellation was profiting from the long bubble in energy prices similar to the way many companies and people were profiting from the housing price bubble. While energy prices were increasing, it was easy to be confident in the trading strategies that were producing profits. After all, when crude oil prices reached $147 per barrel in the summer of 2008, almost everybody seemed to believe that oil prices would soon reach $200 per barrel.

A fourth way in which Constellation was non-transparent was in the way it presented risk using complex mathematical statistics that could not be verified. The company regularly reports “value at risk,” a complicated statistic that supposedly measures the maximum loss that could be realized in one day with a one percent probability. In the third quarter of 2008, the value at risk number was about $30 million. This compares to the actual decline in earnings for the commodities business of $634 million. Dividing $634 by $30 implies there were as many as 21 days of one percent likelihood events. With hindsight, the value at risk statistic was meaningless for risk assessment and it would have been for more useful to simply show what happens to cash flow and earnings at different levels of commodity price or to present a series of scenarios with different commodity prices. Further, in providing earnings projections to investors, the company did not show components of the forecasts and explain how much of the projected earnings increase was due to selling electric power and how much was from marketing and trading. To demonstrate the lack of information in earnings guidance, in the middle of 2008, Constellation earnings guidance for 2009 was about $6.00/share. A couple of weeks later it was as low as $1.50/share.

Once it became apparent that Constellation was taking making speculative bets and did not have the cash on hand available to keep trading, the investors and management panicked, ultimately resulting in the above referenced merger with Warren Buffet’s MidAmerican Energy with extremely onerous terms. The table below illustrates that the credit spreads for Constellation exceeded the spread of Lehman Brothers before the bankruptcy of Lehman. Credit spreads measure the likelihood of bankruptcy and the possibility of recovering debt after bankruptcy. (Chapter 4) The fact that Constellation debt would require a spread of more than 7% suggested that the market believed bankruptcy was a very high possibility, even though the company still had an investment grade bond rating.

**Credit Default Swap Spreads**

| | 1 Year Prior | 6 Months Prior | 3 Months Prior | 1 Month Prior | 17-Sep-08 | 18-Sep-08 |
|---|---|---|---|---|---|---|
| Exelon Generation | 0.638% | 1.702% | 1.138% | 1.353% | 2.292% | 2.392% |
| Exelon Corp. | 0.608% | 1.512% | 1.002% | 1.235% | 1.925% | 2.162% |
| PPL ES | 0.595% | 1.888% | 1.152% | 1.491% | 2.817% | 2.617% |
| PSEG Power | 0.492% | 1.664% | 0.999% | 1.282% | 2.383% | 2.471% |
| IG10 Index | 0.610% | 1.850% | 1.120% | 1.344% | 2.034% | 1.787% |
| Lehman | 0.925% | 4.433% | 2.528% | 3.043% | 7.067% | 7.067% |
| **Constellation** | **0.528%** | **1.793%** | **1.017%** | **1.818%** | **7.650%** | **2.808%** |

The specific reason for Constellation's ultimate financial demise was panic in the financial community that the company could not raise enough cash from lenders provide back-up loans so that it would have collateral to continue its trading activities. If the company were downgraded to below investment grade, these requirements for back-up loans and cash would be magnified. Constellation management defined its finance collapse as a "liquidity crisis" and attributed it to events that were beyond its control -- on "unprecedented turmoil in financial markets," "volatile energy commodity prices" and the actions of rating agencies who were worried about trading partners losing confidence. The downfall began when rating agencies finally recognized (after the fact as was the case for so many other credits) that Constellation had more risks than its peers – the downgrade occurred after energy prices had began to fall. For example, the rating agency Fitch, noted Constellation's exposure to energy prices, implying that it was taking positions in its trading: "Constellation … is exposed to risks surrounding market price, volumes, counterparty credit, and liquidity for collateral." When the company places blame on volatile financial markets for its failure, it is like investors in sub-prime mortgages blaming the fall in housing prices. It is not appropriate to term Constellation as a victim of the financial crisis.

The Constellation story raises a number of valuation issues in the context of an on-going corporation. First, in a case where a company owns a few diverse businesses, use of price to earning multiples can be difficult to apply because of different risks in different business segments. The utility company, being a low growth and low risk company is relatively easy to value. The brokering and global commodities businesses can be attributed little or no value. This leaves the generation segment which depends on the volatile price of electricity and assumptions with respect to long-term cash flow and discount rates. The surprising part of the story of Constellation is not that the price collapsed, but that its valuation had increased so much without understanding the source and risks of underlying cash flows. The case shows that when valuing a company, being able to quantify the risks of business components with a relatively simple financial model is a lot more important than believing fancy words of management. Constellation's collapse also demonstrates that reliance on stable earnings growth is dangerous, particularly if it encourages management to take excessive risks. Finally, the study of Constellation illustrates that growth in earnings is only valuable to the extent that returns are more than the cost of capital. If a company simply makes investments in treasury bonds and grows cash flows through buying more and more bonds, it may grow earnings but this does not create value. Similarly, when Constellation increased earnings through making risky trades, it may have increased earnings, but it also increased risk and cost of capital. As with the treasury bond example, no value was added.

Constellation's demise and the collapse of Enron contained many similarities involving transparency and strategies designed to increase earnings without true competitive advantage. Enron created virtual assets with contracts, brokered power in competitive markets, built power plants with government contracts that should not in theory generate economic profits, created a trading website and attempted to apply its skills in trading weather, broadband space and video rentals. There was not much true competitive advantage underneath most of these activities, but the company was able to obtain a high stock price and high multiples as measured by stock price to earnings and enterprise value to earnings before interest, depreciation and taxes (P/E and EV/EBITDA ratios.)

## Case 6 – Marginal Cost as a Basis for Price Forecasts, the case of Enron's Dabhol Plant

The sixth case considers valuation errors made from not adequately projecting the future level of prices through ignoring or misapplying marginal cost as a guide to the direction and level of long-term prices. The case used to illustrate this problem of ignoring marginal cost and/or wrongly assessing marginal cost can affect value is the large electricity plant named Dabhol constructed by Enron in the Maharashtra Sate of India. Enron constructed the plant after it negotiated prices in a contract with the State of Maharashtra in which the prices would yield high returns and they would most likely remain above the long-run marginal cost over the lifetime of the plant. Financial problems associated with this very large power plant that arose after the contract could not be sustained were a significant contributor to Enron's financial demise in 2001. The plant was supposed to run on liquefied natural gas ("LNG") in contrast to other plants in India that generally used coal; it was the first large independent power project developed in India; it was the largest foreign direct investment in the world; it was Enron's largest single power investment; the cost of the power contract would comprise 50% of the total revenues of the distribution company in Maharashtra; and the project included construction of an LNG terminal, an LNG regasification and an LNG tanker.

Enron began developing the Dabhol electric station together with its co-sponsors Bechtel and GE in 1992 soon after the national government of India announced that the power markets would be open to foreign investors. A memorandum of understanding was signed with the State of Maharashtra when Enron's executives made their first trip to India which mandated that the maximum price of power would be 7.3 cents per kWh. In 1993, Enron and the State reached an agreement on the size of the plant and the contract to purchase power, even though a World Bank report strongly criticized the plant. Enron arranged financing from more than 40 financial institutions for the project and was able to achieve a debt to capital ratio of more than 70% as shown on the figure below (Enron later sold part of its stake in Phase I to the State of Maharashtra). The plant was ultimately scheduled construction for completion in two phases -- in 1999 and 2001 -- with a capacity to produce 2,184 MW of power. The capacity of Dabhol represented more than 20% of the total capacity in the state of Maharashtra when the contract to purchase power was signed. A contract dispute arose between Enron and the new political party in the State of Maharashtra which ran on an anti-Enron campaign (who proposed "throwing Enron into the Arabian Sea".) After a new contract was signed, the plant was closed in 2001 after running for about a year and it did not produce any power until May 2006. Dabhol plant continues to raise strong emotions from different parties. Project Finance bankers and lawyers insist that the Government of India made big mistakes by not living up to a commercial contract which reduced foreign investment and limited the development of infrastructure in the country for years. Others point political pressure that was used by the highest levels of the U.S. government to support an uneconomic investment; to the $20 million of "educational funds" made by Enron which were to explain how capitalism works; environmental problems with the plant and the lack of competitive bidding for the power. The focus below is on the question of how risks of the contract could have been evaluated through evaluating underlying marginal cost rather than on the perhaps more interesting geopolitical issues.

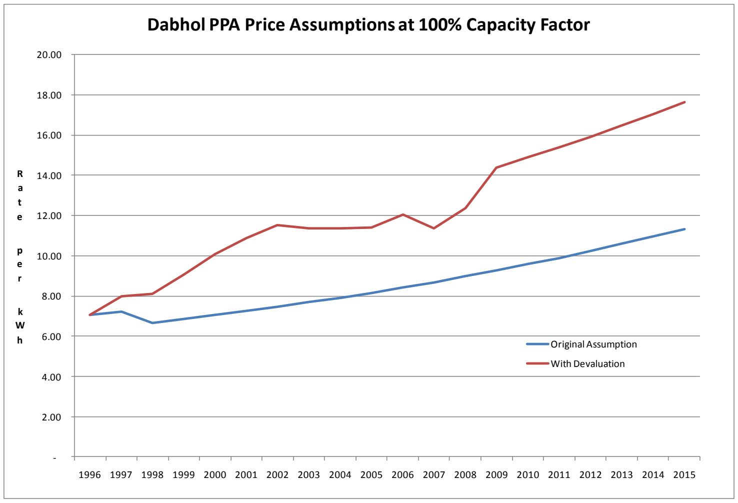
**Dabhol Sources and Uses (Dollars in 000's)**

| | Phase I Amount | Phase I Percent | Phase II Amount | Phase II Percent |
|---|---|---|---|---|
| **Sources of Funds** | | | | |
| Debt Financing | | | | |
| Bank of America/Private Banks | 150,000 | | 497,000 | |
| Indian Banks (Industiral Development Fund) | 95,000 | | 333,000 | |
| OPIC | 100,000 | | 60,000 | |
| U.S. Exim and Export Agencies | 298,000 | | 523,800 | |
| Total Debt | 643,000 | 70% | 1,413,800 | 76% |
| Equity Financing | | | | |
| Enron | 223,000 | | | |
| Bechtel | 28,000 | | | |
| GE | 28,000 | | | |
| Total Equity | 279,000 | 30% | 456,667 | 24% |
| **Uses of Funds** | | | | |
| Cost of LNG Terminal | | | 250,000 | |
| Other Costs | | | 1,620,467 | |
| Cost of Project | 922,000 | 100% | 1,870,467 | 100% |
| Capacity (MW) | 695 | | 1,320 | |
| Cost per KW | 1,326.62 | | 1,417.02 | |

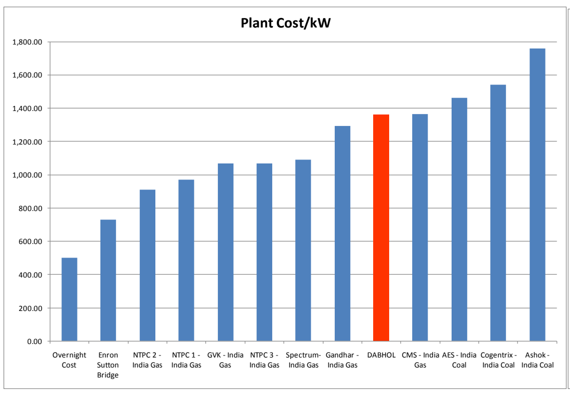
For projects that receive revenues on the basis of market driven prices, the most important component of valuation analysis is generally the assumptions with respect to future price projections that underlie the forecast of future cash flow. This is true also for projects that have long-term price contracts because if the contract price differs by a wide margin from prices that would arise from spot markets or from current costs, there will be a lot of pressure to exit the contract. While coming up with a long-term forecast prices is certainly not an easy task, one principle that can provide some structure to price forecasts is that in a reasonably competitive market, prices cannot indefinitely be sustained above or below long-run marginal cost. A corollary to this principle that prices converge to marginal cost is that when oversupply exists in a market, prices remain below long-run marginal cost until demand justifies construction of new capacity and that where a lot of over-supply exists, prices can fall all the way down to short-run marginal cost. While these economic principles are quite basic, many valuation errors have been made by assuming that fundamental of economic principles somehow will not apply to a particular investment. Further, analysts often concentrate on the demand side of the process which does drive volatility and short-term price movements. However, over the long lifetime of an investment, assuming that prices remain well above or below marginal cost -- the supply side of the equation – is dangerous.

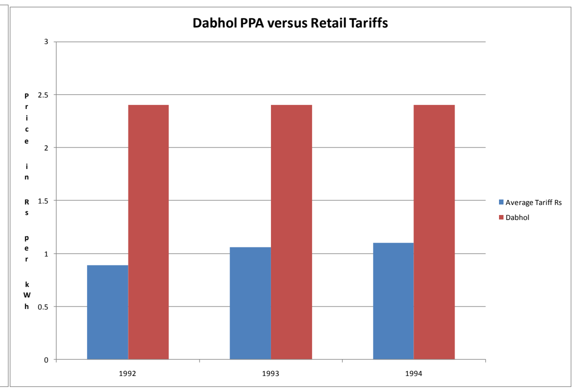
When Wall Street commentators shout that the oil price driven by supply and demand they often speak in very general terms that mean little because nobody knows what they really mean by supply. Assuming a reasonably competitive market, over the long period in which cash flow is produced by an investment, the supply curve and prices are defined by long-term marginal cost. If all costs are fixed or variable and if all technologies have the same mix of fixed and variable costs, the analysis of marginal cost is simple. Here, one simply computes the capital and operating cost of adding new capacity to the system on a per unit basis. (Chapter 6) However, when capacity can be added with different technologies that have different tradeoffs between fixed and variable cost (as is the case for most industries) the marginal cost is more complicated to compute. Consider for example the case of an airline deciding what kind of airplanes to add to its fleet. The economic analysis and the marginal cost of owning a ten-year old Boeing 737 is very different than the analysis of a new Airbus A380 and one use the cost of one technology to substitute for the other. Similarly, copper or coal mines with different mixtures of fixed and variable cost may both be economic, but the prices required to keep the mines operating is very different. Finally, even if a project is efficiently constructed at a low cost, if it is the wrong technology because of an oversupply of plants with a certain cost structure, it may be an uneconomic investment and its cost may be above the overall marginal cost. (Chapter 6)

In assessing the cost of Enron's Dabhol plant, it was ambiguous how high the cost was and even whether the plant costs were higher than long-run marginal cost. To make the analysis, it was necessary to come up with an effective definition of marginal cost. The definition of marginal cost is driven by capital costs of building net capacity, the cost of capital, projected increases in productivity, forecasted operating expenses and other factors such as tax rates and equipment lives. In the case of the Dabhol power plant, when Enron and the State of Maharashtra negotiated the original contract, Enron agreed to establish a price of 7 cents per kWh. This simplistic mandate turned out to be a big problem for Maharashtra as Enron was able to come up with a price of 7 cents price and at the same time produce a high level of profit for itself through mandating that the plant would run as long it is available and by inflating the price over time. This worked for Enron because the fixed costs could be spread over as large as possible a volume on energy. The problem with this is for consumers in Maharashtra is that the contract that mandated the plant would run as much as possible did not reflect the variable cost of operating a plant that must purchase LNG or naphtha which and has a much higher than the running costs of other plants such as coal plants. If the Dabhol plant operated and caused Maharashtra to pay its cost of producing energy from LNG while lower cost plants were available and not running, then there was a waste that was benefiting nobody. It is as if you choose to drive an inefficient low mileage SUV instead of a hybrid when there is no benefit from the added space in the SUV. When Dabhol was operated in the order of its variable cost in 2000, its utilization was as low as 33% rather than the above 90% required to obtain a price of 7 cents. Part of the problem was that the optimistic demand forecasts (growth in demand of above 10%) that were originally made for the plant did not materialize. All of this means that the 7 cents number that Enron published was not relevant. The real cost of the plant depended on how often it was economic to operate the plant as well as the exchange rate. There was 49% devaluation in the Rupee which led to an increase in price because the power contract was indexed to U.S. dollars. The graph below shows the price in the contract assuming the plant would be operated at full capacity using the original exchange rate assumptions and actual exchange rates.

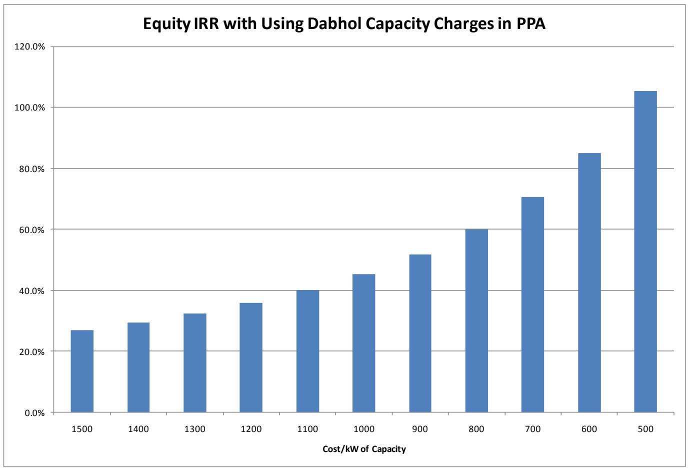


A couple of years after signing the contract, the State-owned distribution company that purchased power and officials from the State of Maharashtra believed the contract price was too high and by implication that investment in the LNG plant was not economic. The plant had began operations in 1999, but by October 2000, the State-owned utility company stopped paying for the power. Enron was an aggressive negotiator and had obtained what seemed to be very strong guarantees from the State as well as the federal government of India. Ultimately, the process of realizing these guarantees turned out to be very difficult to effect and resulted in years of litigation. The story demonstrates that bankers and sponsors should have concentrated more on thinking about the underlying economics of the project and less on taking comfort from government guarantees. Further, in assessing the cost of the power from the project, one had to separate the aggressive arguments of Enron from political arguments made by the project opponents. Enron would send people with MBA's from Harvard who spoke very fast, used sophisticated language and suggested that their projects were very beneficial. Their presentations would be supported by three ring binders with glossy pictures that were very impressive. In Harvard case study write-ups on the plant that were written with the help of Enron management compared the plant costs and attempted to show that the cost was not dramatically higher than the cost of other plants in India as shown in the left panel below. Opponents noted that the cost of Dabhol was dramatically higher than the existing electricity tariffs as illustrated in the right panel below.

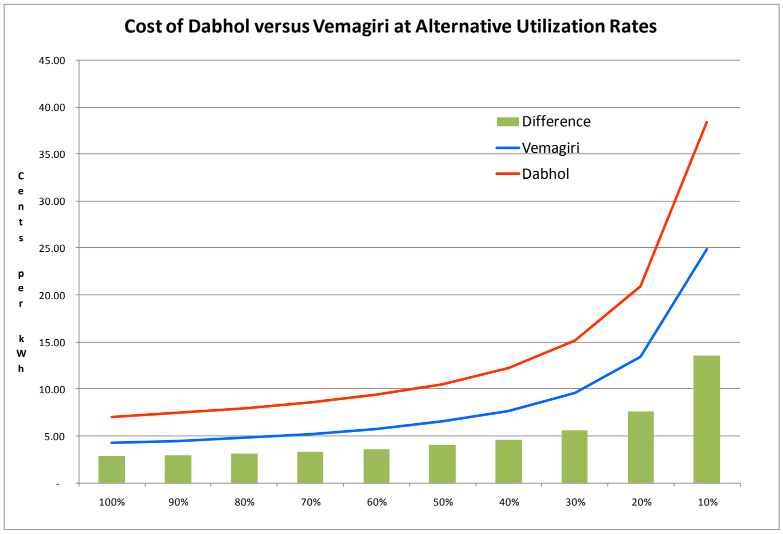



In making cost comparisons for purposes of valuation a good approach is to search for data on as similar projects as possible and account for the variable and fixed cost structure of the investment. In the graph above that was suggested by Enron as a basis for evaluating the cost of Dabhol, some of the plants were not competed and some were coal plants. On the other hand, the comparison of Dabhol tariffs for generation of electricity with the subsidized rates for distribution, transmission and generation of electricity that were aging is also not relevant to measuring the cost of new capacity. One power plant that is more comparable is a natural gas fired plant named Vemagiri built in the neighboring State of Andhra Pardesh. This plant had a capital cost that was about 50% of the cost of Dabhol -- the cost per kW was $741/kW for Vemagiri while it was about $1,400/kW for Dabhol. Both Dabhol and Vemagiri used similar combined cycle technology. The graph below shows the rate of return realized on equity using rates that recover the cost of capacity in the Dabhol contract assuming various different plant costs (the plant costs per kW are shown on the x-axis and the return is shown on the y-axis.) As the plant had a cost of between $700/kW and $800/kW, had this plant been able to receive the same capacity charge as Dabhol, its rate of return equity would have been above 60%. Thus, from a capital cost perspective, the cost of Dabhol seemed to be very high.




An economic comparison between the plants should consider all of the costs, including capital and operating costs. This can be accomplished through comparing the prices that would have to be paid by consumers at different capacity utilization percentages. If one plant has lower capital cost but higher operating cost, then at some point with high utilization the overall combined fixed and variable costs per unit produced may be lower. However, in addition to having a lower capital cost, the Vemagiri plant also had lower variable running costs than Dabhol. The graph below shows that the overall cost of Dabhol was higher than the comparison project over the spectrum of capacity factors. The bars demonstrate that the difference in the cost per unit is aggravated at low utilization rates. From this comparative analysis one can conclude that the Dabhol plant had a cost of about 55-65% above the long-run marginal cost. The Dabhol plant demonstrates that being brilliant at negotiating contacts with government agencies may seem to generate high profits, the risks of depending on prices far above marginal cost cannot ultimately not be avoided.



The previous section described how valuation of investments will eventually converge to the underlying cash flow based valuation. Similar principals apply to price variables that underlie many cash flow projections where prices are set on a reasonably competitive basis. In this case, rather than values not being able to deviate indefinitely from the risk adjusted cash flows, the prices cannot deviate from long-run cost of production indefinitely. As with valuations, the prices may deviate by large margins and for relatively long periods. However, as long as there is some semblance of competition, then new entry and demand growth drive prices toward marginal cost. As with valuations that are derived on some other basis, when analysts say that a price variable such as the oil price is high because investors are looking for a place to put their money, the argument sounds persusave, but it does not stand up. In this case, if the price was higher than cost, one would lose money if one were to hold the oil. However, as long as the storage costs are not high, the current price should reflect the future price, because if the price was expected to increase, then one would hold current stocks.

Do not have to be expert in extremely precise estimates, but must understand how prices can move in the long-term. This leads to cyclicality in prices that is so often missed as analysts who pay undue attention to recent trends. Refer to chapters on forward price and marginal cost. Discussion by television analysts refers generally to supply and demand. Instead, understand cost curves and long-run marginal cost. Of course, actual prices may never attain the long-term marginal cost level. In the short-run prices can deviate from long-run marginal cost by wide margins. The volatility in prices is driven by changes in inventory and the ability to store, changes in variable cost, temporary capacity shortages, collusion and many other factors.

In valuing assets, the potential for prices to deviate form the long-run cost (required to sustain IRR equal to the WACC) must be considered. In particular, if prices will be driven below cost during the beginning of the project operation the value may detoriate by a wide margin. The limits on price are driven by short run marginal cost in the downward direction and the cost of customers finding alternatives on the high side. Inelastic demand drives price spikes while the ability to store things in inventory limits price volatility.

## Case 7 - Understanding Uncertainty in Demand Growth, Signing Contracts in the Philippines

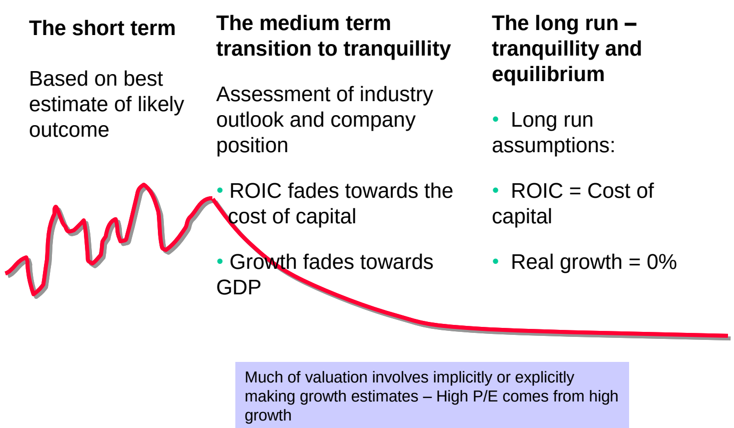
The seventh case considers valuation mistakes from not properly accounting for the flexibility of cost structure of companies in the face of unpredictable demand. The specific case involves uncertain demand forecasts in the Philippinnes which were very costly to businesses and people in the country because of a strategy that fixed the cost of power. When projecting cash flows, there is invariably some kind growth rate prediction that must be made, whether it is the growth in revenues, demand, prices, cash flow, earnings or productivity.

As introduced above, valuation boils down to forecasting future cash flows and then assigning risk to those case flows. As should be apparent already, the problem with valuation analysis is that both of these things are so difficult to measure.

Valuation errors addressed here involve mistakes in prediction of growth when valuing investments -- specifically not being humble about how difficult it is to predict growth rates in demand. The conclusion from reviewing case studies of growth rate prediction is that instead of believing that growth can be accurately forecast, valuation analysis should explicitly consider the risks of overestimating or underestimating growth. The cases demonstrates how a risk analysis process that may include sensitivity analysis, break-even analysis, scenario analysis and tornado diagrams is more reasonable than attempting to incorporate risk in the cost of capital.

Three prominent examples of growth rates that are central to measuring value include terminal growth rates estimated in standard discounted cash flow analyses ("DCF"); earnings per share growth rate forecasts made by equity analysts; and forecasted long-term demand growth rates in project finance analysis. In a standard discounted cash flow model, consultants, investment bankers and analysts typically create valuation models of corporations through projecting un-leveraged free cash flows over a five to ten year time frame and then applying a growth rate equal to or slightly above the rate of inflation to the cash flow forecasted in the final explicit year of the forecast. This growth rate in cash flows applied to cash flow in the terminal year along with the cash flow level at and the date at which the terminal year occurs are invariably two of the most important variables that drive the valuations, but often little thought goes into the analysis. The second example involving valuation models developed by equity analysts, often depends on projection of earnings growth over the next few years. Once growth is estimated, analysts often adjust valuation ratios such as the price to earnings ratio in an ad hoc manner according to these earnings growth estimates. Finally, valuation analyses that are derived from long-term cash flow projections implicitly or explicitly rely on some growth rate projection – growth in traffic, productivity, demand, real price or some other factor. To properly value investments in all of the three circumstances, growth rate projections by necessity must often be made for a period of two or three decades.

Not surprisingly, prognostication of future growth is a notoriously difficult part of valuation, despite the simple rules used my many analysts. The tendency of investment analysts to be optimistic in their projection of earnings per share growth is a lively subject in finance[46] and there are many studies documenting the upward bias of equity analysts who surprisingly do not seem to evaluate their forecasts after the fact.[47] In contrast to the equity analysts, investment bankers who perform discounted cash flow analysis generally make a surprisingly pessimistic assumption that growth in cash flow once a terminal period occurs will be limited to the projected rate of inflation. The valuations depend on the assumption that companies will somehow "stabilize" to a tranquil zero real growth rate in a period of somewhere between five and ten years, perhaps after a smooth transition period until the supposed tranquility is obtained. While the assumption is commonly made, it is difficult to come up with any company -- or person for that matter -- that has reached this kind of tranquil nirvana or has managed such a transition to equilibrium. Further, the valuation analysts do not seem to be concerned about the basic point that if all companies somehow reach this kind of equilibrium where there is no real growth in cash flow, no companies would contribute to real economic growth and the world economy would stagnate in a never-ending recession. An illustration of the type of growth rate assumptions made in classic DCF analyses is shown in the graph below.[48] Of course, the date at which the transition from short-term to long-term growth occurs and the length of the transition period is arbitrary.




[46] McKinsey and Chan from testimony

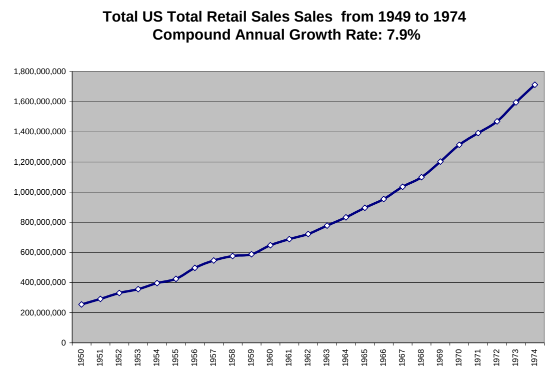
[47] Black Swan Reference

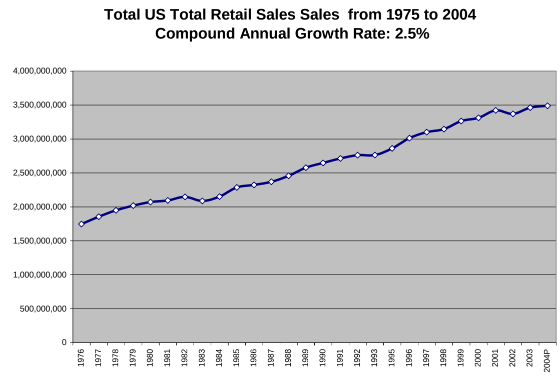
[48] Growth rate in the transition period can be constructed from the equation: $g_t = g_{t-1}$ x[1/(short-term growth/long-term growth)]^(1/transition period).

While questionable logic (such as assuming world economic growth will stop) and errors in the prediction of growth are pervasive in valuation, the errors in valuation analysis discussed here are not related to under-estimating or over-estimating growth. Precisely because the exercise of predicting growth is so difficult, it would be presumptuous to assert that valuation analyses were flawed when someone made an optimistic or pessimistic estimate – growth rate uncertainty is a big part of the reason that cash flows themselves are uncertain. Instead, the analytical mistakes described here are related to appropriately accounting for the fact that one cannot precisely determine when the growth rate in a company or an industry will begin to moderate. Given the inherent uncertainty of guessing at what date growth rates will change, investments that can more easily respond to changes in growth rates or are less sensitive to growth rate variation should be valued more highly than investment strategies which cannot easily adjust to changes in growth. Valuation errors occur when the value of this flexibility to adjust to changes in growth rate is ignored.

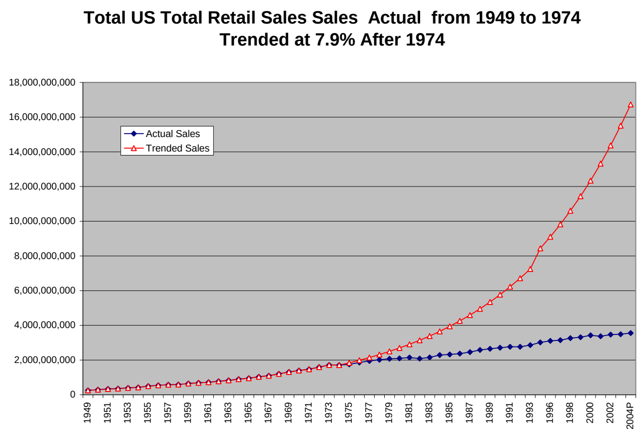
In many industries, delusion that growth rates will continue have led to dramatic valuation errors. For example, in the U.S. sub-prime crisis of 2007-2008 involving home mortgages, the assumption that prices of residential homes would steadily rise resulted in aggressive lending practices. Of course this assumption that housing prices continue to grow could not be sustainable, particularly in light of the increased supply of houses that occurred as a result of the lending practices themselves. Errors in growth projections of housing prices had disastrous effects on bank balance sheets as well as the economy of the whole world. In the electricity generation industry, serious mistakes have been made by not considering how uncertainty in demand growth affects alternative investments. Two situations are presented below in which valuation did not appropriately consider the ability of investments to react to different achieved rates of demand growth. The examples include signing long-term inflexible contracts by distribution companies in the Philippines and the construction of electricity capacity with long lead time in the 1970’s and 1980’s in the U.S. Mistakes from not properly accounting for risks associated with different potential growth when considering investment possibilities resulted in enormous costs to investors and consumers in both cases.

In the U.S., electric power demand grew at a compound growth rate of 7.9% from 1949 to 1974 and then, in years since, it has grown at a much smaller compound growth rate of 2.5% which is roughly comparable to the level of overall economic growth. The change in growth rate that occurred in the mid-1970’s implied that growth did indeed stabilize corresponding to the standard assumption so often made in DCF models (although the growth did not decline to zero corresponding to the typical assumption.) It is tempting to suggest that the change in demand growth rates in the 1970’s was predictable – with hindsight it is of course easy to criticize many historic forecasts. The achievement of stable year to year growth above 7% in the 1950’s and 1960’s naturally led managers to make projections of similar growth rates for subsequent periods. Using historic data, a trend line forecast would surely have outperformed any other multiple regression or complex time series analysis method. As illustrated by the graph on the left below, history of electricity power demand growth did not seem to suggest that growth rates for this industry would stabilize.




While examination of historic trends on the first graph would imply that historic growth will continue, a growth rate of 7% -- which is well above the real growth rate in the economy -- was in fact not sustainable over the long-term for a couple of obvious reasons. First, if demand for a product is projected to grow at rates above the overall real growth rates in economic activity, that product would eventually become the whole economy (if electricity grew at 7% and the rest of the economy would grow at 2%, electricity would be the only product in the economy in thirty years.) Second, high growth rates are very difficult to sustain for long periods simply because of the fact that the business becomes large and growth rates from a low base are much easier to achieve than growth rates from a high base. Because there was no historic evidence of a growth rate other than 7%, only by using judgment and not relying on historic data could the growth rate decline have been predicted. Had the trends in growth rates from the earlier 1949-1974 period been used to project future growth, the errors in demand projection would have been enormous and the errors would have grown with longer projection periods as shown in the graph below. The red line shows growth that would have occurred if historic trends had continued while the lower blue line shows the actual demand.



Given the history of demand growth, electricity companies in the 1970's decided to build many coal and nuclear plants with long construction lead times since these plants were though to be far more valuable than investments with shorter construction periods such as oil and natural gas plants, particularly after the oil price shocks of 1973 and 1979. Oil and natural gas prices were rising and larger plants were thought to have significant economies of scale. When growth did not materialize, many large plants that were in the midst of being constructed were not cancelled (managers ignored the value of the option to cancel because of psychological attachment to investments) and massive surplus capacity remained in the market for more than a decade. The surplus capacity led to contentious price increases for consumers as well as billions of dollars of write-offs associated with surplus capacity that accrued to shareholders. The problem of building investments that could not adjust when demand change lasted into the 1990's until demand growth finally caught up with supply. With hindsight it is apparent that managers should have employed more flexible strategies through construction of a portfolio that included smaller plants with less construction lead time that could have responded to changes in demand – even if these plants had a lower value in the base case scenarios which projected continued high growth. While this value of flexibility and risk analysis of alternative growth seems obvious with hindsight, most valuation analyses in the 1970's concentrated on a base case scenario and the amount of time and analysis spent seriously studying exposure to factors such as changing growth rates was limited. It is tempting to fault analysts in the industry for not predicting the date at which the change in demand growth occurred. The real problem is not performing risk analysis that considers the possibility of changes in demand growth when comparing investment alternatives.

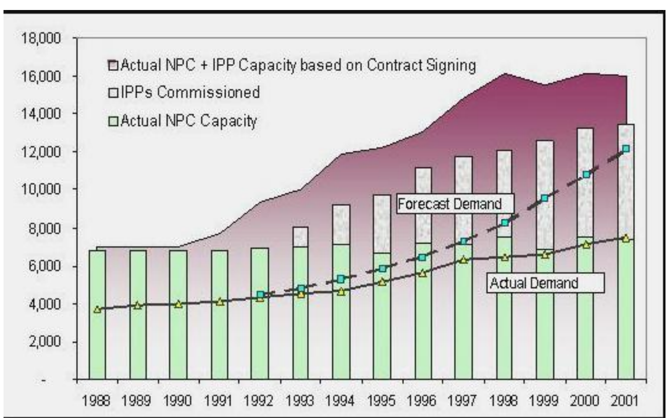
The Philippines has experienced similar problems to those discussed above where investments are premised on sustaining high levels of demand growth. In this case the problems arose from signing long-term take or pay contacts to purchase power which could not be adjusted in the case of lower than expected demand growth. During the 1980's demand growth in the country had been strong [TRY TO FIND DATA] and the Bantam nuclear station (two 600 MW units) commissioned to meet the demand could not begin operation. From 1989 to 1993 power shortages resulting from increased demand and problems with the nuclear plant caused brownouts of 4-8 hours per day in Manila and resulted in large economic losses estimated at 1.5% of GDP.[49] In response to the power shortages, state-owned and private distribution utility companies signed long-term contracts with 35 independent power generators to construct new capacity of 8,425 MW relative to demand of about 4,000 MW. Needless to say, the value of the contracts depended on realization of a lot of growth.[50]

When the long-term contracts, known as Purchased Power Agreements (Papas), were established, it seemed that simply by signing contracts, the Philippine power shortage could be alleviated and better yet, the Philippines government would not even have to borrow money to rectify the problem. From the perspective of private developers, who agreed to construct capacity under the contracts, the focus was on obtaining attractive equity returns through raising high levels of debt and securing political risk insurance. On the other hand, policy makers likely emphasized the costs of not having sufficient capacity to meet load rather than the risks associated with uncertainty in demand growth. After the fact it is clear that instead of exclusively locking into long-term contracts, power should have been secured through waiting for growth to materialize and then either signing short-term contracts or contracts for less expensive peaking capacity.

[49] Report of Philippines Department of Department of Energy,
[50] Secretary Vincent S. Pérez, Jr., Department of Energy, 06 September 2002

Distortions in evaluation of the risk from the manner in which plants were financed is illustrated by the case of a 123 MW bunker fuel power plant named Subic which developed by Enron Corporation at a cost of $142 million or $1,157 per kW (more than double the cost of combined cycle natural gas plants built in Western Europe and the U.S. at the time). The plant was able to achieve a high level of debt financing because it signed a 15-year contract with the state owned distribution company NAPCOR that included a capacity charge of $260/kW/year (more than four times the $60/kW/year carrying charge estimated used for peaking capacity in the U.S. at the time.) From the perspective of Enron, the risk of uncertainty in demand growth was not relevant since a power contract assured revenues. The relatively low risks of cash flow were demonstrated by the fact that the plant was able to obtain 72% debt financing (even though it did incur a relatively high credit spread of 3.85%.) Private financing of the plants was possible as long as multi-year contracts with no flexibility that transferred risk away from developers such as Enron.

The Enron contract and the other contracts were signed in anticipation of increased demand growth. When the contracts were signed, the aggregate national demand was about 4,000 MW. However demand growth did not materialize, in part because of the higher prices caused by the contracts themselves. As shown in the graph below, demand was projected to grow by 10% per year and hit almost 12,000 MW by 2001, whereas actual demand grew at only 2% and reached 6,000 MW. Because of the long-term contracts, capacity reached about 16,000 MW in 1999 implying a reserve margin – surplus capacity divided by load -- of 167% (a 15% to 20% reserve margin is considered adequate in the U.S. industry.) Since the contracts included fixed obligations that had to be paid no matter what the overall demand was, they created enormous financial distress for the state owned utility company and they caused a general mess of the whole economy of the Philippines. For example, settlement of the power contracts and bailout of the distribution company is estimated to have cost $14 billion due in part because of devaluation of the Philippine peso which increased power purchase cost 170 billion pesos to 240 billion pesos.[51] Because of the power contracts, residential power rates more than doubled and industrial rates are the highest in Asia.[52]




[51] Philippine Center for Investigation, 5-8 August 2002. Trail of Power Mess Leads to Ramos, Kuz Rinbon and Shelia Sumonte-Pesayco.
[52] Alecks Pabico, Short-circuited Reforms in the Power Sector, 16 November 2007.

The lesson of the Philippines and the U.S. cases is that valuation analyses of investments should explicitly consider the ability of economic investments or contracts to respond to uncertainty in economic variables – particularly the uncertainty in growth rates. In both situations there seemed to be little recognition given for the possibility that historic growth would not be a good predictor of future growth. With hindsight it is clear that the manner in which the investments respond to unpredictable growth should have been a central parameter in assessing the value of investments. Traditional financial theory would suggest that somehow the weighted average cost of capital should be increased for the investments which have less flexibility with respect to growth and therefore higher uncertainty. Modern theory may frame the issue of flexibility with respect to demand growth as a real option and assign a premium to the investment strategies that are more flexible. In practice, even if one could come up with reasonable methods to derive the cost of capital or the option premiums, it would be very difficult to explain these risk adjustments in a convincing manner to management.

Rather than measuring risk of different investment alternatives by attempting to quantify the discount rate associated with specific investments, a more risk analysis process could surely be developed which directly simulates alternative demand growth possibilities. In developing such an analysis, the cost of experiencing higher electricity outages would have to be gauged against the cost of paying for surplus capacity that is not needed to meet demand. Once a range of demand growth scenarios would be obtained, the value of the strategy with no flexibility could be compared to the value of a flexible strategy. In the U.S. case, the flexible strategy would involve plants with higher expected cost and shorter lead times while in the case of the Philippines, the flexible alternative may have been to consider quickly building additions to existing plants without the long process of project financing. The value of the flexible strategy would be compared to the value of the less flexible strategy under a range of different growth rates. Because of the ability to not commit to capacity long before demand growth is realized, the distribution of value of the in-flexible alternatives would have been wider than the distribution of value of the inflexible alternatives.

With hindsight, decision making in the two cases discussed above would have been improved through performing risk analysis with respect to different growth rates. While the inflexible long-lead time investments or the PPA agreements may have looked more valuable with higher growth, risk analysis would illustrate an alternative outcome. When thinking about what it means to perform risk analysis or to be a risk manager, one may imagine a person working on value at risk quantification using volatility statistics and complicated mathematical models. However if one were to construct a risk analysis process to assess the value of flexible investments with respect to growth, it is probably more effective to begin with far simpler techniques. First, you could begin by simply developing a sensitivity analysis that graphically presents the value of the flexible (e.g. short-lead time strategy) and the inflexible alternative (long lead-time strategy) with different growth rates. Next, you could find the break-even growth rate before which the flexible alternative becomes less valuable than the inflexible alternative. Through assessing the probability of the achieving various growth rates you consider potential variation in the growth rate along with other variables such as the oil price, inflation rates, interest rates etc. The scenario analysis could measure the relative value of upside cases, downside cases and other possible combinations of assumptions so that you could determine which combination makes the flexible alternative more or less valuable than the other. Since the scenario analysis does not tell you which variable has the largest effect on relative value, a tornado diagram could be presented that ranks the impact of variables on the relative value of the different alternatives from the highest to the lowest and then presents the impact of the changes in value from a downside case to an upside case on a graph. Finally, you could come up with a mathematical equation for demand that accounts for the variability in demand over time and then develop a Monte Carlo simulation. This would provide you with an explicit probability distribution of the relative value of the two investments and you could directly see both the risks and the costs of the two strategies.

It is tempting to suggest that the Monte Carlo simulation approach is the best way to evaluate risk, but in realistically assessing risks, the most useful tools are probably in the same order as the above list. The most useful techniques are the sensitivity analysis and the break-even analysis while the Monte Carlo analysis provides a nice way to demonstrate that you have performed sophisticated analysis. Chapter 3 includes a discussion of how to implement and analyze the different risk analysis techniques. Chapter 2 describes how to build financial models that form the basis for risk analysis.

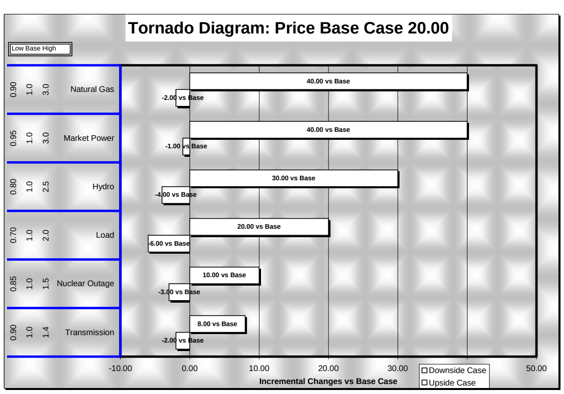
## Case 8 – Understanding Upside and Downside Risk, the Case of Restructuring of California Electricity Markets

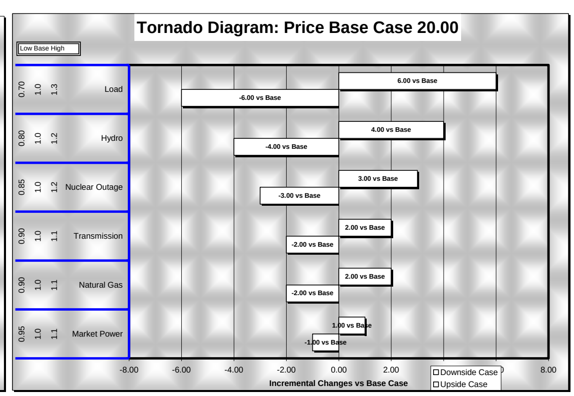
Typical process is to spend a lot of time on the base case. Then they may create a downside case and upside cash that is symmetric to the base case – the upside case is as optimistic relative to the base case as the downside risk. In other words the downside case makes economic variables somewhat worse and the upside a little better. The problem is that in the real world, relationships are not linear and upside potential does not equal downside exposure. The valuation mistake discussed here involves ignoring or not correctly estimating the potential variation in different variables.

In developing ranges of price forecasts that underlie cash flow forecasts, valuation analyses are often clustered in a narrow range rather than accounting for the full dispersion in possible prices, volumes, and costs. Further, forecasts tend to be upwardly biased and clustered in a narrow range rather than accept the probability of prices falling to a lower boundary. The credit rating agency Standard and Poor's states that " ." For capital intensive assets, prices can fall to short-run marginal cost when surplus capacity exists in a market and in some cases this contingency should be considered in valuation.

Problem with historic data. First error made by not evaluating history and somehow assuming that history will not repeat.

In developing cash flow projections that underlie valuation analyses, the potential upside is often assumed to be equal to the downside and linear extrapolations are made from historic data. A lot of time is typically spent on a base case forecast and then the downside and upside cases are relatively simple adjustments to the forecast. Contrary to these typical methods, real world data often does not have a symmetric distribution and relationships are sometimes relationships between variables are highly non-linear. If the downside does not equal the upside and/or if cash flow distributions are skewed, then the valuation analyses will be wrong. I

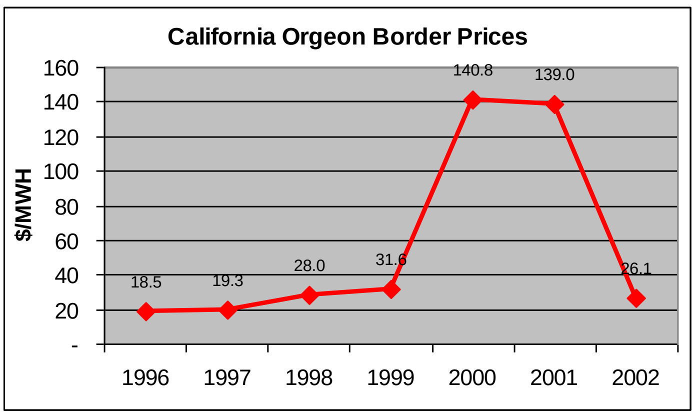


A well known problem with valuations using discounted cash flow is that many distributions do not have symmetric distributions. The reason real call options to cancel, expand, retire, and operate a plant have value is that the options limit the downside potential of the cash flows. These real options imply that the discounted cash flow model understates the true value of assets to some degree. The magnitude of the error caused by neglecting real options depends on how the option affects the skew ness of cash flows. This skweness in turn is driven by the volatility in the cash flows and the ability of management to make decisions influences the cash flows.

Real options do not necessarily increase the value of an asset if the options can be exercised by customers or government policy makers. Here the option limits the upside potential of the cash flow and it increases the downside exposure. Neglecting to consider the downside exposure can result in valuation errors. Such was the case associated in California. In negotiating provisions for de-regulation, California utility companies agreed to cap their prices to customers and pay prices for power that were subject to fluctuations and were not similarly capped. The agreement allowed the utility companies to recover the cost of previous inefficient decisions from customers. This policy effectively created a call option for customers limiting their downside exposure to high power prices in return for making payments for the prior inefficient decisions. It also created a put option for the utility companies exposing them to increases in power prices. When developing the policy it was assumed that prices for purchasing power would remain relatively stable and that prices would only reach high levels for a few hours per year. It was also assumed the markets would operate in an efficient manner without companies exercising market power.

In 2000 and 2001, prices of purchased power increased dramatically as shown on the graph below. The California market had no separate capacity market as with the PJM market, the pre-NETA UK market and the Argentina market. The California market contrasted with other power markets because it has a relatively high reliance on hydro generation and natural gas and the transmission network can become congested.

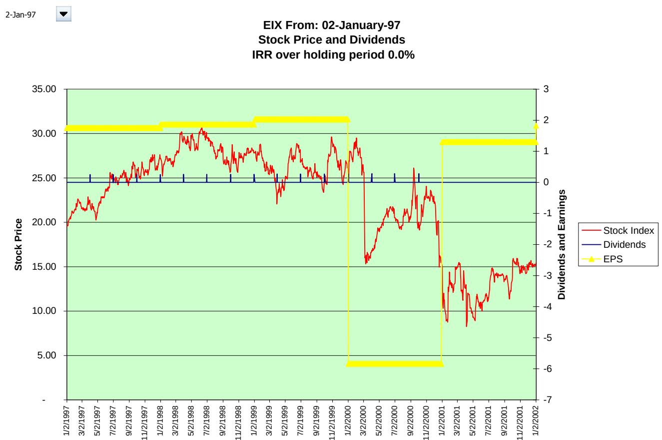



The above graph demonstrates the dramatic volatility that can arise from a capacity shortage, high fuel prices and low hydro output. There were many reasons for the high prices including demand growth, insufficient capacity additions, transmission bottlenecks, increases in the cost of natural gas, reduced hydro output, nuclear plant outages, exercise of market power, shortages of environmental emission allowances and limited demand response. A lively debate has arisen as to how much of the price protracted price increase was due to cost increases or excess profits earned by suppliers.[53] A notable aspect of the annual California prices was that there was little signal in the historic prices themselves that suggested a dramatic rise in prices would occur.

Also discuss Zion and South Africa.

[53] See Robert McCullough, "Price Spike Tsunami: How Market Power Soaked California," *Public Utilities Fortnightly*, January 1, 2001, pp. 22 - 32.

For the utility companies, the realization of high purchased power prices and the inability to pass along the higher prices because of the price cap policy led to the bankruptcy of Pacific Gas and Electric and financial distress of Southern California Edison. The stock price of Edison International – the holding company for Southern California Edison is shown below.



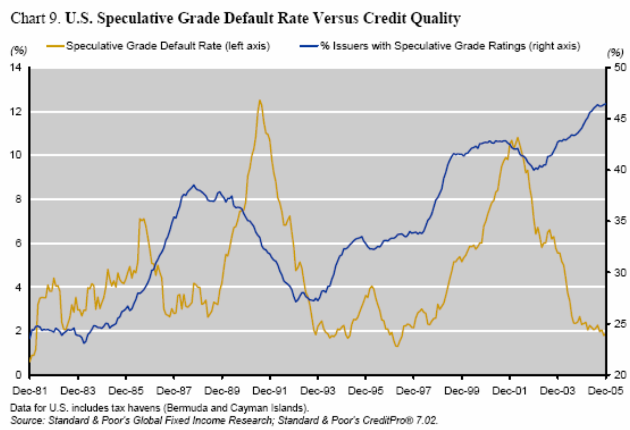

The fundamental lesson is to perform and understand risk analysis – this means examining the underlying variables and attempting to construct implicit or explicit probability distributions of the variables and the interaction of the variables.

The effect of real options on asset value is described in Chapter ___. The chapter describes problems with measuring these options and how to practically apply the techniques in the context of electricity plants.

Discuss correction and appropriate analysis of the distribution of cash flows. Analysis should consider extreme values which often cannot be gauged from historic data and assumption that distributions will follow normal distributions.

When reviewing valuation mistakes such as those made in the Eurotunnel case, one often wonders why seemingly obvious checks on complicated models are often not made. One of the potential answers is simply the desire for bankers, consultants and lawyers for earning fees. With the potential for earning fees, financial analysts seem to be able to make themselves believe stories that would seem ridiculous to others. Nassim Taleb terms this as the firehouse effect which holds that firemen with much downtime who talk to each other for too long come to agree on many things that an outside, impartial observer would find ludicrous (they develop political ideas that are very similar). After changing the business world in the 1980's, leveraged buyouts became more risky. In their text, Koller, … [FIND QUOTE SOURCE] "[w]e have reviewed some financial projections that underpinned several high-profile LBO bankruptcies in the late 1980s. Many of these transactions were based on assumptions that the companies could achieve levels of performance, revenue growth, operating margins, and capital utilization never before achieved in their industry." The authors suggested that the reason investors did not question these "shoddy analyses" was due to fee potential and the tendency for one bank not to question the analysis of other banks: "In many of these transactions, bankers and loan committees felt great pressure to keep up with their peers and generate high up-front fees, so they approved highly questionable loans. In other cases, each participant assumed someone else had carefully done the homework. Buyers assumed that if they could get financing, the deal must be good. High-yield bond investors figured that the commercial bankers providing the senior debt must surely have worked their numbers properly. After all, the bankers selling the bonds had their reputations at stake, and the buyers had some capital in the game as well. Whatever the assumption, however, the immutable laws of economics and value creation prevailed. Many deals went under."

Results of the aggressive assumptions in terms of the default rate on junk bonds used to finance many of the leveraged buyouts are shown in the graph below. The graph presents the number of defaults divided by all bonds that had a rating of BB+ or lower. From 1981 to 1985, the default rate was around 4%, suggesting that a credit spread of about 4% would have been sufficient to cover risks (the appropriate credit spread is described in detail in Chapter 4.) From 1989 through 1992 the default was much higher, reaching 12% in 1991 which resulted in a dramatic decrease in the number of issuers such as leveraged buyouts.




Conclusion – use economic principles described in Chapter 3 and Chapter 6. Use break-even analysis described in Chapter 3 for complex variables.

## Not exiting investments and exercising option to cancel
## The case of cancellation and retirement of nuclear power plants in the US.

Refer to options chapter – many options are options to get out of investments. Option to retire, option to cancel development, option to cancel research, option to close company, option to get out of merger. This is why options valuable. Problem is that exercise requires giving up psychological attachment to assets and admitting that you are wrong.

Examples of exiting investments – well known cases of financial investments. Refer again to Taleb and reluctance to sell when things are bad. Just as prevalent in small business that has been successful but conditions are more difficult. The natural situation is to wait far too long before realizing that the business should be closed.

Most discussions of valuation analyses include a portion on real options. The popularity of real options and use to increase the value of assets after the proliferation of financial assets. If one increases the valuation of an asset for options associated with management flexibility, then the manager of the asset must exercise the option to delay, cancel, mothball, or retire the asset when it is profitable to exercise the option. Unlike financial options where the option is clearly exercised when the actual price is above the exercise price, exercising real options is ambiguous. If ideal decisions are not made, the value of assets changes.

US nuclear plants provide a series of case studies in valuation mistakes from failing to exercise real options. Since nuclear plants have a very long construction period and construction expenditures have high volatility, the option to cancel construction should in theory increase the value of the investment. Similarly, because significant capital expenditures are required to extend the life of a plant, the option to retire in different periods can be valuable.

The value of cancellation and retirement options are illustrated with the hypothetical case below. The example below assumes a 10-year construction period, volatility in prices of 25% and volatility in construction costs of 40% (for further discussion, see Chapter 4.) With these assumptions, the option to cancel asses ___% to the value of a plant.

In the 1980's, nuclear plants faced massive cost over-runs. Further, combination of decreased demand, low fuel prices, and capacity additions meant that the operating value of the plants was much lower than the original expected value of the plants when construction commenced in the 1970's. These events implied that the option to cancel the plants should have been cancelled. However, in actual fact, few plants were cancelled in part because of regulatory procedures that allowed completed plants to earn higher returns than cancelled plants and due to general reluctance to cancel plants.

In deciding whether to retire a nuclear plant, management must continually assess incremental investment and the power prices. Decisions were made to retire nuclear plants were made when prices were low, apparently ignoring the potential dispersion in future prices. For example, the Zion nuclear plant was retired in 1998 when prices were low and when capital expenditures were required for a new generator. With hindsight, management had made the wrong as the value of nuclear plants increased with higher natural gas and electricity prices. Had the option value been considered and time series prosperities been included in the analysis, the decision would have probably been different.

The implications from this case are that options to abandon should be part of the valuation analysis, but the option must be exercised correctly. Further, the option must consider the distribution of cash flows.

For example, investors eargly put money into a telecom venture named Iridum which had very high costs and technical risk. The handsets cost more than $1,000 and the cost per minute was $1.

## Errors in Not Using Information that can Strip Risk Away from Cash Flow The Case of the MCV Cogeneration Plant

Why would ignore the pricing of real contracts. One simple idea has been behind finance theory and that is arbitrage.

The value of a generating plant is affected by a myriad of contracts that can reduce or eliminate variation in revenues and expenses. Valuation issues associated with contracts involve whether the contract provisions increase, decrease or do not affect value through altering the risk profile of the asset (where risk reduction may be traded off for cash flow reduction.) Using risk measurement tools developed in the chapter, contracts can be valued using a variety of financial and statistical models.

Discuss taking the risk out of the cash flow and using the risk free rate. When it is possible to take the risk out of the cash flow through forward markets, contracts and insurance policies, this information cannot be ignored in valuation. Risk neutral valuation sounds like some sort of esoteric theory, but with a little creativity, it can be applied to various different problems.

There are various examples of risk neutral valuation that can be applied in valuation:

If an oil field is being valued, it can either make estimates of forward prices and use a high discount rate or it can use forward market prices. A more rigorous valuation comes from using forward prices and a risk free rate. For example, assume an existing oil field is being sold and the production volumes, operating costs, annual decline rate and other components of the project are known. This leaves the oil price the remaining risk. At first blush, one would think this project still has high risk because of the volatility of oil prices and a relatively high discount rate should be used in valuation. However, the same project could lock in oil prices through use of forward markets. In this case there is no risk in the transaction and the risk free rate is appropriate. The oil field is exactly the same and the value should be the same. The method which removes risk from the revenues and uses a risk free rate provides a more rigorous valuation than the approach that uses uncertain prices and requires estimates of a risk premium in the discount rate.

If there is a construction contract that includes a premium – say 20% to eliminate cost over-run and delay risk; this verifies the risk rather than attempts to simulate the risk or use of a high discount rate.
If there is a long-term contract that fixes the price, the project can be financed with a lower discount rate.

If a project can secure political risk insurance to eliminate political and currency conversion risk, a lower discount rate can be used rather than attempting to measure political risk.

The third graph presents energy prices for the electricity market in Argentina. Argentina uses a pool system where prices are established from the cost of the last unit to dispatch rather than competitive bids and the design includes a pre-set capacity price where suppliers earn a given price per MWH as long as there capacity is available. Along with the UK, the Argentina market attracted substantial new merchant power plant investments. Unlike the UK and PJM systems, the capacity mix in Argentina includes substantial hydro capacity and less than ten percent of capacity in the market is owned by one firm.

The graph of annual average prices demonstrates that prices in Argentina experienced a significant decline after a competitive market was established. Falling prices in Argentina were due to in part to additions of combined cycle plants, improved efficiency, and increases in hydro energy production. As with the UK market, serious financial consequences have resulted for merchant power plant investors from the low prices which were not anticipated when the plants were developed. The Argentina price decline demonstrates the effect that changes in the productivity of new capacity can have on long-term prices. Unlike price movements that result from changes in demand, capacity additions or fuel prices, the price changes that result from productivity changes do not a tendency to revert back to average levels. Once prices declined in Argentina because of the improved heat rates of combined cycle plants, the prices did not move back to prior levels.

Try this – make very extreme assumptions -- assume no storage cost and no interest cost and could delay consumption. Also assume that future long-run cost is 75 as defined by extracting oil from expensive areas such as tar sands of northern Canada or finding oil in difficult to find areas in the Artic Circle. If the current price is 150 and one holds the oil as an investment, the investment will produce a loss. On the other hand if could somehow delay the use of oil, one would wait and use the oil when it is 75. The price would then converge to 75. Similarly, if the price was 20 today, then one could buy the oil today and make a profit. Similarly, if one was using oil, one could use it today instead of delaying the use. All of this would push the price to the long-run marginal cost. Of course, the assumptions about storage, interest rates and delaying usage are ridiculous, but the general point of understanding long-run marginal cost is still valid. The question is how long prices can deviate from the long-run cost level and when will they eventually move to the long-run cost.

Other arguments against basic valuation include the suggestion that the Saudi Arabia market bubble around 2005 involve theorizing that too much money is chasing limited opportunity for new investments, meaning that one shouldn't worry about P/E ratios, discounted cash flow or any other valuation approach founded on cash flow produced by a particular company. Arguments against fundamental valuation from observable cash flow can become quite sophisticated and they are made by very smart people who speak very quickly on conference calls and speak intelligently in television interviews on CNBC.

Traditional discounted cash flow does not give credit to the option to cancel or the option to expand and therefore undervalues the company. As long as the company can grow revenues and spend money, the potential for realizing this option to expand will exist.